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LECTURES

ON

PLANTS, FERTILIZATION,

INSECTS, FORESTRY,

FARM HOMES, ETC.

BY HIRAM A. CUTTING, M. D., PH. D.,
Secretary of Board of Agriculture.

MONTPELIER, VT.
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1882.

E.V.

WILD FLOWERS AND OBNOXIOUS PLANTS.

BY DR. HIRAM A. CUTTING.

OUR FRONTISPIECE.

Through the generosity of JAMES VICK, that noted and honorable dealer in plants and flower seeds at Rochester, N. Y., we are enabled to give in this volume a frontispiece of early spring flowers, found wild in Vermont, yet of surpassing loveliness. How eagerly the youth of our State search for those first flowers on May day. Those brave little fellows that, unheeding frosty nights, herald the approach of summer. Some do not claim to love nature; but who among us, when spring is long delayed, does not welcome the first flowers as they would the sight of long-absent friends? Even the symplocarpus, or "skunk-cabbage," has a cordial greeting. But, wherever it grows, the *epigœa repens*—"May-flower," or "trailing arbutus," as it is commonly called—is loved, and not alone for its beauty. Often seen double (it is represented in both forms in the plates), and varying in tint through the various shades of pink, and so fragrant as to be eagerly sought by all, it is truly a gem. The flower-buds are formed in autumn, and when the weather is mild during the winter, they seem ready to burst, standing in the midst of snow, expectant for the first soft breezes of spring-time.

The cultivation of the trailing arbutus has often been attempted with unsatisfactory results, and it is a plant that can never be packed and expressed over the country with hope of changing its nature; but it is not wholly untractable to proper efforts. It is a wild plant and it will remain essentially so, but this delicately tinted, sweet-scented blossom can be made a companion of man. To have it flourish in your care you must have a little grove of trees, not too shady or yet too open, but just shady enough to break the scorching rays of the sun, which will burn up those rich evergreen leaves, and yet admitting sun enough to prevent that white growth that so often makes your lilacs look as though flour had been sprinkled upon them, and yet which no rain can wash away, known as "egg mould," on account of its peculiar appearance when magnified. It must be undisturbed by scythe or rake, or any gardening tool, and the spot where it is planted must be profusely supplied with plenty of leaf mold like that found in its native haunts. After all this has been prepared for it, it must be removed from its native spot with great care, and with as much soil as possible upon its roots, with a good sprinkling of water now and then; they must be otherwise let alone and allowed to repair damages as they see fit. With this attention only, it will take kindly to your care, and if not trampled

upon or treated unkindly it will come to stay. Rose Terry, one of our own poets, says of it:

Darling of the forest!
Blossoming alone
When earth's grief is sorest
For her jewels gone—
Ere the last snow-drift melts, your tender buds have blown.

Tinged with color faintly,
Like the morning sky,
Or more pale and saintly,
Wrapped in leaves ye lie,
Even as children sleep in faith's simplicity.

There the wild wood-robin
Hymns your solitude,
And the rain comes sobbing
Through the budding wood,
While the low south wind sighs, but dare not be more rude.

Were your lips fashioned
Out of air and dew:
Starlight unimpassioned,
Dawn's most tender hue—
And scented by the woods that gathered sweets for you?

Fairest and most lovely,
From the world apart,
Made for beauty only,
Veiled from nature's heart,
With such unconscious grace as makes the dream of art!

Were not mortal sorrow
An immortal shade,
Then would I to-morrow
Such a flower be made,
And live in the dear woods where my lost childhood played.

THE WINTERGREEN.

Gaultheria procumbens, or checkerberry, with its globular red berries and evergreen, shining, spicy leaves, so fragrant, and yet the fragrance belongs to the evergreen leaf itself and not to the flower. It is well represented in the plate. It is a first cousin to the arbutus, and they often grow near each other, as though the aroma exhaled by one could be enjoyed by the other, yet the first exhales from the flowers only and the latter from its leaves. Upon the left of the plate may be seen the

LIVERLEAF.

Hepatica triloba. The leaf from which this plant takes its name being three lobed, and often of a dark purplish color on the underside. Like the others already noticed it is evergreen. The flowers, like those of the arbutus, vary from pink to white, and also like them attempts the multiplication of its petals, and as bluish double flower as a result may often be seen growing side by side with a single white one. The common name is not an attractive one, hence it is in some sections better known as the liverleaf anemone, as it is to botanists to be

known in the future under its first name given by Linnæus, anemone hepatica—perhaps that is the most appropriate. Vick in his *Illustrated Monthly* says of it:

"This plant takes to garden culture as kindly as the arbutus persistently refuses it, and it is not at all necessary to provide it with shade. It will flourish and bloom in profusion year after year with the most indifferent attention; it is easily transplanted, and is a gem in the garden in early spring, showing its bloom before any other flowers make their appearance, except the little snowdrop that appears in the plate just underneath it. One who has not hunted for native wild flowers in early spring will be surprised to learn how many make their appearance soon after those of the first arbutus and liverleaf. If we could only bring the various kinds together into the garden it would be greatly enriched and beautified at a time when, as usually seen, it is stark and poverty stricken. With the liverleaf appears the little spring beauty, or claytonia, of which there are two species, bearing, however, a close resemblance to each other. And then follow in quick succession many others, one of which is the blood root, sanguinaria Canadensis, the large white flowers represented in the plate. It is certainly very admirable and is capable of being enjoyed to advantage, for it does not complain of removal from its wild haunts on the borders of the woods and along the fence sides. Now we might mention the trilliums and erythroniums, or dog's tooth violets, the bellworts, or uvularias, the toothworts, or spring cresses, the dicentras, and many others. We have a wealth of native flowers, and many more of them should find places in the garden than usually do; but especially do the very early spring flowering plants, perfectly hardy and adapted to the climate, demand more attention. It would be a surprise to many of our readers to learn how great a number of our native plants are cultivated in English and European gardens, that in this country are seldom seen away from their native haunts. The hardy, beautiful, native orchidaceous plants alone, that may be cultivated, would make a glad surprise in any garden if properly managed. We are aware that a great variety of the native plants are in cultivation, but it is by the few comparatively, not generally and according to their real worth. But gradually, as their merits become better known, they will be more highly prized. The little daphne cneorum, which also has evergreen foliage, very properly accompanies the native flowers exhibited in the plate, since in the garden it blooms about the same time. Wherever this plant will succeed it is most charming. It grows only about a foot in height, having a procumbent habit with age and thus spreading laterally but not growing upwards. When thriving it blooms profusely, the flowers being a little larger than here represented; besides their attractive color set off by the rich green foliage, they emit the sweetest perfume. Although this plant will succeed fairly well in most soils, it has a decided preference, to be sure not so positive as that of the arbutus, still strong, for a soil composed in great part of vegetable matter and with comparatively little lime. Besides, if it can have shelter from the sun by a position on the north side of a group of evergreens, or even low-branched de-

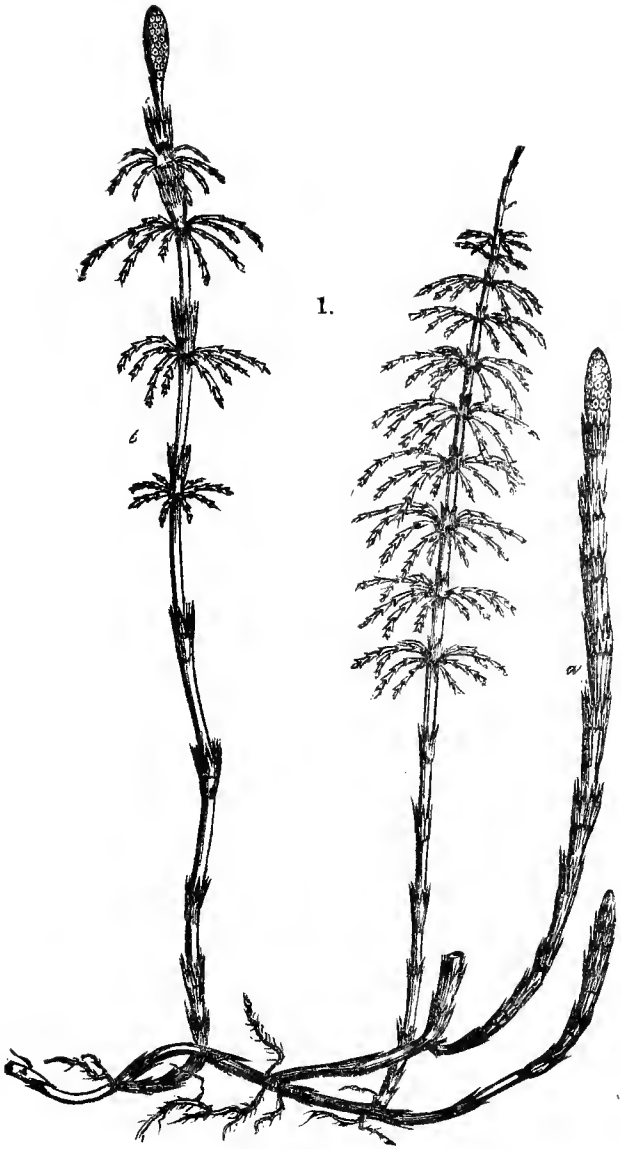
ciduous shrubs, it will be better suited than elsewhere. Any of these plants can be transplanted in the fall after the first of October.

SO-CALLED POISONOUS PLANTS.

In almost every locality the farmers have peculiar notions about poisonous plants; as direct experiments have been made by myself and others upon some of them, I pass several in review. Perhaps the one generally considered injurious to horses, and known as horsetail, has laid to its charge as many injurious effects as any plant well can have. It is said to produce scouring by some, heaves by others, and still others believe it produces various ill effects, until nearly every disease in the catalogue of horse ailments is charged to it.

WOOD HORSETAIL,

Or *equisetum sylvaticum*, is the most usual variety, and grows on almost all natural grass lands, liking dampness, if not excessive.



Wood Horsetail.

In the cut, at *a*, may be seen a fertile shoot not containing chlorophyll, bearing the sporangia at its summit; *b*, a fertile green shoot; between these a sterile green shoot. These three kinds of shoots do not always occur, and yet they do quite frequently, but the brown color of the fertile stems is at once distinguishable. The other variety

EQUISETUM ORVENSE,

grows on dry ground, and is specially found on railroad embankments, holding possession for several years before it is crowded out by any other plant. The fertile stems first appear, and are from six to eight inches high. The sterile stems are rather higher than the fertile, and remain through the season, after the fertile ones have decayed. At each joint is a whorl of simple rough branches. This is the "field horsetail," and either of the two mentioned varieties are very common through the State.

Now, from what description I have given, I think all will know the plant, though in some sections it is called foxtail, in others, meadow pine, ground pine, horse rush, etc. It is the prevaling opinion that colts fed upon it will sicken and die, and that all horses are injured. I have frequently heard it asserted that no colts could be raised that fed upon it even in small quantities. Tradition says it scours horses, but facts do not verify any assertion made. I raise hay for the market, and also keep stock, and as hay containing it does not sell as well, I feed it, selling the clear hay. I have raised colts upon that mixed hay and they came up sound and all right, making valuable horses.

I did not know but that when green, as it contained so much silex, it might scour horses, so I have fed it green to horses in stable, and it has no bad effect. I believe it entirely harmless. It does not afford much nourishment, and is not desirable on that account.

Prof. Asa Gray says of those plants that he has never known any injury from them, and suspects, notwithstanding the tradition, that they are quite innocent of any harm.

From my own experience, and all I can learn of the experience of others, I believe them innocent and harmless food, of no special value, yet without danger in the use of hay containing them. In medicine a variety of this order known as the

SCOURING RUSH,

or "*equesetum hyemale*," is used as a diuretic; but this property even is so slight that it is disputed, and many physiciane do not ever use it, as they think it of no value. This further shows that this order of plants while nearly worthless are not injurious.

Fool's parsley.

Aethusa, or fool's parsley, is not very common in the State, yet I find several towns which are troubled with it. It has an acrid taste, and many farmers believe it poisonous to cattle. I do not find that cattle will eat it, either green or dry, and hence were it a poison it cannot do harm. While some farmers fence off the fields where it grows, neither using them for meadow or pasture, I deem this bad practice, for it is a weed hard to eradicate and the seeds grown on waste land are almost sure to find root elsewhere. I have allowed it to go into my hay, cautiously at first, but finding it does no harm I pay no attention to it. Early and continuous cutting will kill it as it will any foul weed. The appearance of the plant may be seen in the cut. It is found on semi moist, stony places, but by certain marks its identity can be established from all other plants having the same habit. Each partial umbel of flowers terminating the stalk has, at its base, three approximate narrow pointed bracts, or floral leaves, which hang vertically downward as seen in the cut, where its leaf is also well represented. Its flavor and odor are unpleasant, and its seeds nauseous. It grows from two to three feet high, and has a peculiar shade of green. Flowers small, white, and in clusters, as shown in the cut

CHICORY,

sometimes called "succory," is the *cichorium intybus* of the botanist, a plant so hardy that it is likely to become naturalized wherever it is introduced. In some sections of Vermont its showy sky-blue flowers on hard branching stalks from one to two feet high are all too numerous, by the roadsides, in pastures, and on tillage land. It is a native of Europe; was first used in France to adulterate coffee, and the peculiar bitter of its root when properly prepared, together with the extraordinary cheapness of its production, and withal its tonic and alterative effect, recommended it not only to the trade, who by its use gained much larger profits, but to the consumer, who had at his command a very cheap substitute for that expensive beverage that was becoming so common in all households. Perhaps I ought also to state that popular as it is, it does not contain any of

the essential ingredients of coffee, though the use of it to adulterate that article has become world wide. As it has a hard stalk with few leaves, it is almost worthless for hay, and on the whole is one of the most pernicious weeds that the farmer has to contend with. It has doubtless been brought into the State as a garden plant, that farmers might raise it and use it in place of coffee. But as it soon escapes from the garden, I trust in future, should any be foolish enough to plant it, that they will guard it with jealous care.

DAISY.

Next to this, perhaps, comes the daisy, the *bellis perennis* of botanists, so called from the Latin work "bellus"—pretty; yet that fatal beauty has cursed New England with one of the worst of foreign weeds. At first cultivated in the flower garden for its showy white flowers, sometimes single, at others quilled or double, it at length escaped from the control of the garden to be naturalized in all parts of New England; and it will soon be so over the whole northern United States. Like the chiccory it has a hard stalk, but will rapidly creep in as other plants die out; and as no soil is too poor for it, the thriftless farmer finds little else to make hay of, and it is well for him that it makes a very good food for his cattle. It is easily pushed out by the various grasses on rich soil, and under the hoe it is not a hard weed. With many it is a question whether we are the worse for it; but I think that is easily settled by the testimony of those that have it. Though I have asked the opinion of hundreds, I have never found a man but what would say that if he did not have it he would use his utmost endeavors not to get it on to his farm.

CATCH-FLY.

Another specimen, which I am glad to say does not greatly abound in Vermont as yet, is a great pest in Canada and in Europe. It is usually called bladder campion, or catch-fly, but to the botanists is known as *silena inflata*. Like the others it came from Europe, but unlike them it seems never to have been utilized for any purpose, and as its seed balls are not only numerous, but contain many seeds, it seems to spread with a rapidity that astonishes all farmer. It is from one to two feet high, with a small white flower; and is worthless and noxious everywhere. It is found scattered over Europe, Asia, Africa, Canada, and is creeping into Vermont. It will soon be world-wide, and though judicious laws may check it, it will doubtless over-ride all sanitary regulations and gain foothold in the end.

For all this, judicious legislation should check the ravages of many of our noxious insects, as well as pernicious plants, and we trust that the present legislature may make a beginning by passing laws against some at least, if not all of our pests.

PLANT GROWTH AND FERTILIZATION.

BY DR. HIRAM A. CUTTING.

To the farmer the soil has a certain importance. It is the home of the roots of all his crops, and there, unseen, they work for his advantage, giving him large profits; or by refusing to perform their accustomed labor, mete out to him losses and poverty. Through this soil alone can he influence the amount of vegetable production, for the atmosphere which furnishes so large a share of the plant; or the sun that by its light and heat perfects the growth, are altogether beyond his control.

The science of agriculture is in the proper culture of the field, as it is only through the soil that the plant can be fed. The value of the field lies in the quality of its soil, and the successful farmer is the one that can judiciously, without too great expense, not only hold the present fertility of the soil, but continually increase it, so that his increased profits will more rapidly accumulate, and his land also become more valuable.

As Prof. Johnson says: "No study can have a grander material significance than the one which gives us a knowledge of the causes of fertility and barrenness, a knowledge of the means of economizing the one and overcoming the other, a knowledge of those natural laws which enable the farmer so to modify and manage his soil that all the deficiencies of the atmosphere, or the vicissitudes of climate cannot deprive him of a suitable reward for his exertions."

The amount of rainfall or sunshine is beyond our control, but we may so prepare our land that we can mitigate the evils and gain benefit from the good.

This is a great study for the husbandman. We can hardly blame the average man that he shrinks from grappling with the unseen, and I had almost said unknown. But, thanks to modern science; thanks to the energy of the men who till the soil with an observing eye, it is not all unknown. That there is much to learn is true, but much has been already wrenched from nature, and man can soon say that he has dominion over the soil of the fields, as well as the beasts he feeds with the product thereof.

It was Jansen, who by reflection and deep thought upon the magnifying power of a drop of water, which had previously been observed for centuries, that gave us the microscope, and improvements upon the same have given us great knowledge, previously unthought of.

It was the almost accidental reasoning of a watch maker that gave us the telescope, and the improvements made thereon have revealed the wonders of the heavens.

It was Isaac Watts' half muddled mind that instigated him to snatch the flask containing boiling liquid from the fire, and thus reveal the power of steam, which with the improvements after applied gives us the most powerful servant of man.

It was Baron Liebig that first directed thought to supplying concentrated fertilizers to the growing plant. The improvements have given us many advantages, yet so little actual experiment has been had with the plant itself that we are in the midst of improvement, and it is with the hope of advancing general knowledge by stimulating the mind of man to investigate further, that I speak of my own experiments in connection with the investigations of others, hoping I may at least direct the inquiring mind towards success.

First we need know what we wish to nourish; and how we can do it. You may say that we well know it. The plant, the stalk of corn or grain is composed of some thirteen different materials, and yet only from one to five per cent come from the earth. This is true, and of the sixty-five elements existing on earth, the plant is in reality mainly made up of thirteen. Occasionally others are found, but the elements that are considered essential are carbon, oxygen, hydrogen, nitrogen, calcium, magnesium, potassium, sodium, iron, sulphur, phosphorus, silicon and chlorine.

The first four, which constitute the bulk of the plant, are, as I believe, wholly obtained from the atmosphere, yet many pretend to supply nitrogen through nitrogenous material, but I do not believe it usually necessary to spend money in that direction, as will be seen further on.

But while we are well acquainted with the part of the plant that is above the ground we seldom take trouble to examine the roots, and when we do examine, as a rule we pull up the plant and by that act strip off and destroy all the little mouths which fed the plant, leaving them in the soil. It is little that we pull up but the branching stem of the plant, destined by nature to hold it in proper position, that it grow erect, that it may develop the seeds. The innumerable little rootlets are not seen, and it is those rootlets that contain the mouths we desire to feed, and they are much more abundant and reach further from the plant than most of us have any idea.

One of the first investigators was the scholarly Schubart, and to gain an idea of those little feeders he made an excavation in his field six feet deep, and still wider; excavating in such a way that he had a drain for water used, and then by forcing a stream of water against the bank washed the dirt away, revealing the rootlets. His first experiment was in a field of rye, then in one of beans, to be followed by one of garden peas. They all presented, when two or three inches of dirt was washed away from the side of the perpendicular bank a complete network of fibres like felt, covering the face of his excavation to full four feet from the surface of the ground. He afterwards observed the roots of winter wheat seven feet beneath the surface, and only forty-seven days after sowing. The roots of clover one year old penetrated to a perpendicular depth of three and a half feet, and afterwards increased with its age. Hellriegel

also studied them and says that the rootlets are innumerable, and yet constantly branching until every crevice and pore of the soil is full of them. After careful investigation he believed that the oat, barley and other grains had, including the branches, from one to two hundred feet in length of roots.

Prof. Atwater of Wesleyan University says: "I have some roots of timothy, clover and other plants, dug from a very heavy clay soil, a good quality of brick clay, so compact and hard that a sharp knife in cutting it leaves a surface as smooth and shiny as it would on the end of a pine board, and yet the roots of timothy penetrated to the depth of two feet four inches and the clover three feet and two inches in this soil." J. Stanton Gould says he traced roots of Indian corn seven feet beneath the surface, and Prof. Johnson has not only found them several feet beneath the surface, but in a light, sandy soil extending fifteen feet from the corn stalk. Prof. Stock bridge washed out clover roots one year old in the alluvial soil of the Connecticut, finding them to extend perpendicular eight feet below the surface

Lucern roots are stated to have reached the depth of thirty feet, and parsnips have been dug thirteen feet six inches in length, and I have found that the common blood beet sometimes equals that in length of tap root, yet it usually extends but four or five feet, throwing out many branches. The drawings made from actual roots washed from the soil (as well as all others presented), and drawn by Miss Florence M. Cassino of Salem, Mass., show definitely the condition of the roots at different stages of two, four and six weeks from planting, the largest having a tap root twenty-nine inches long.

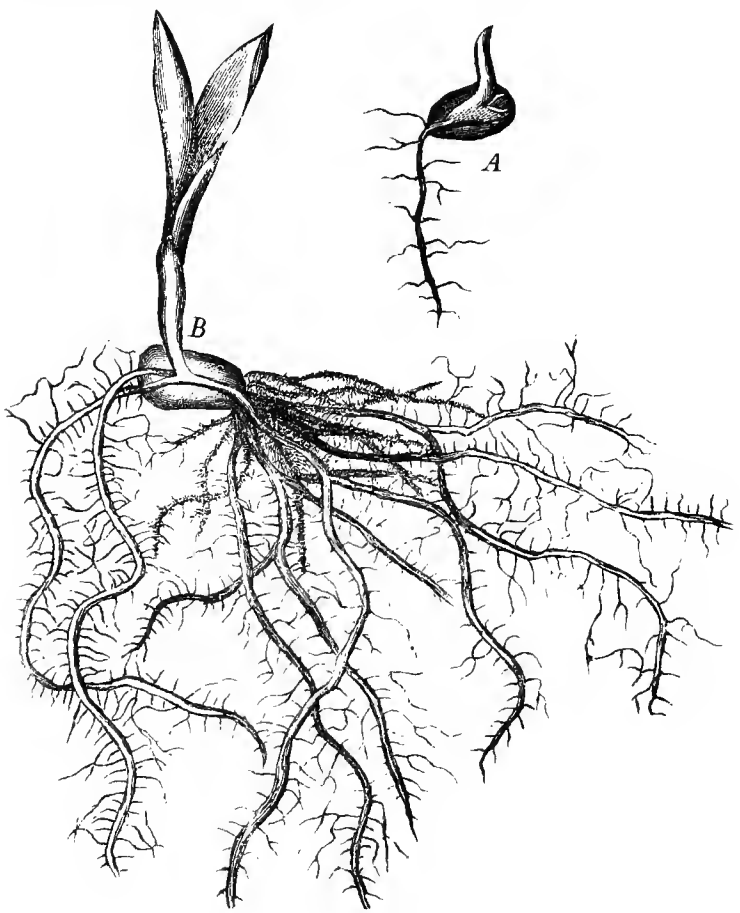
The different stages of growth are represented by figures 1, 2 and 3.

That the exact condition of the rootlets might be obtained they were put in a glass jar of water, and in that way they seemed to assume natural positions, and the drawings, by the skilled artist as she was, were absolutely perfect.

Beet Roots.

It would be more interesting if we could have the same root represented in the three different stages, so that the change could be noted, but as that could not be, I have endeavored to obtain healthful, good-looking plants. Of course the roots are covered with minute hairs which are too fine for the pencil to represent, constituting so many mouths to feed the plant.

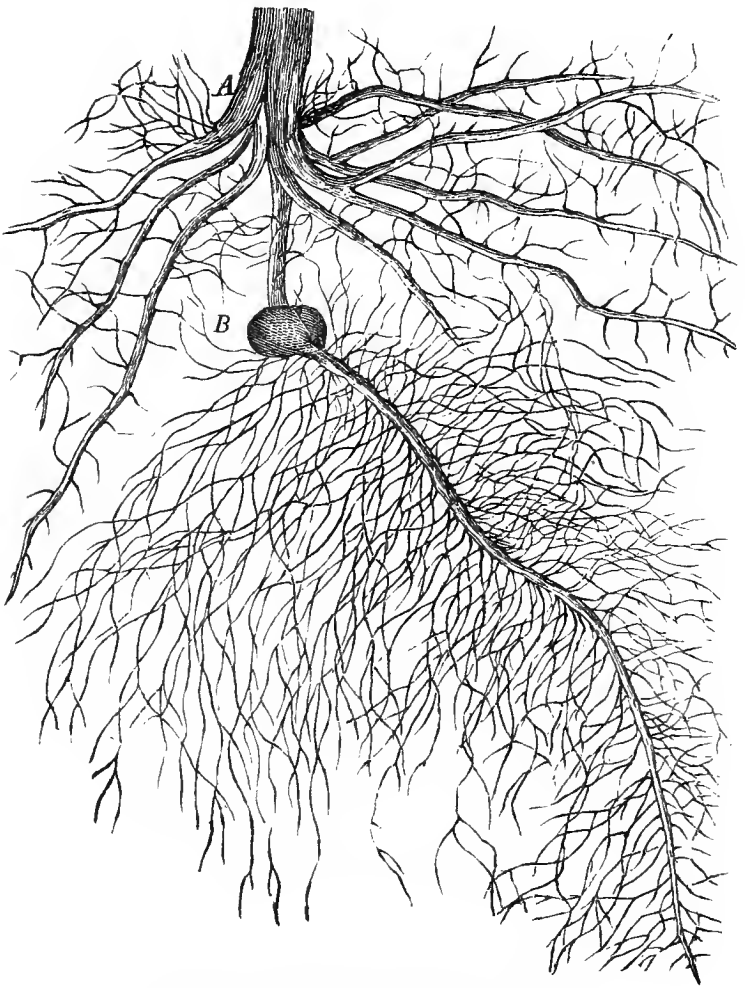
Our next representation is of Indian corn, and is of the greater interest as all previous figures used in various books seem to have been made by guess work. In the *American Agriculturalist* for 1880, are various figures of the rootlets of Indian corn, but all fail in showing it as I find it by washing out the same.



Indian corn.

A sprouted—B where stalk is two inches high.

At A, the corn is represented as just sprouted, the plumule, or stalk, tending upward and the tap root directly downward. In a few hours after sprouting, little rootlets extend from the end of the kernel that aid in the rapid growth of the young plant, and in developing the first tier of sucker roots, which are sent out a few days later. The kernel with its rootlets thus attached may be seen at B. A few days later the roots assume the appearance seen in the second cut, when the stalk is about five inches high.

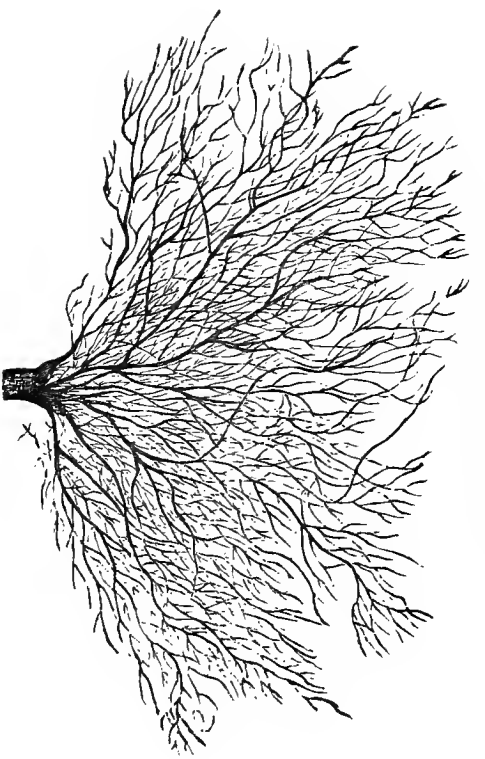


Corn roots at a growth of five inches of stalk.

The first tier of sucker roots are extended as seen at A, and the tap root has progressed to the length of ten or twelve inches, and has sent out hundreds of feeders in every direction. The stalk is now about five inches high and is prepared for growth, as the roots extend surprisingly, gathering in the food in large quantities, pushing the stalk rapidly upward. The little rootlets are so small that they are hardly visible to the naked eye, and as the corn approaches maturity they really fill the ground, so that there is hardly a square inch of it that is not permeated by the hungry mouths of the corn plant.

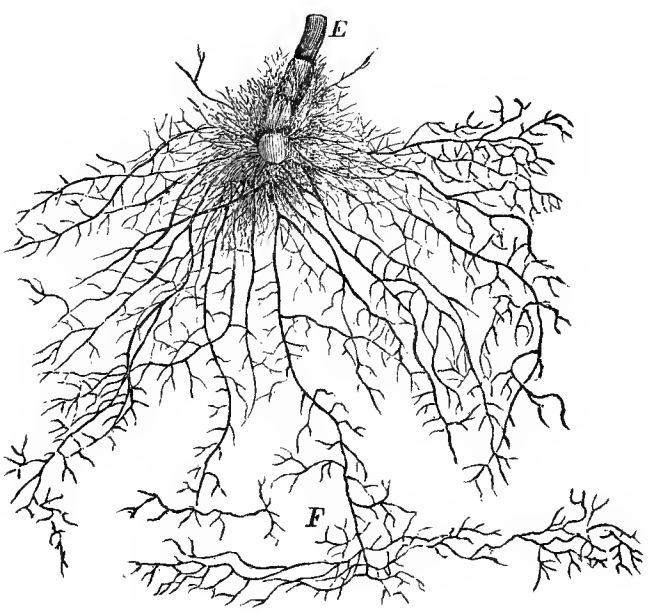
It is advisable for every farmer to examine these representations, or what is better, wash out and examine the roots themselves, and they will then better understand the care of their corn fields. Most farmers have noted how after weeding with the hoe, plowing between the rows, as usual, that their corn stands still, as they express it, for a day or two; and when cultivated with the Thomas smoothing harrow it seems to grow right along. The reason is evident; the plow and hoe disturb more dirt and injure more rootlets, and put the others further from the air and sunlight than before. The harrow disturbs only the surface, letting air and light into the soil, injuring slightly, it is true, some of the stalks, yet leaving the ground undisturbed except at surface; hence the corn grows on as though not molested.

Farmers are agreed that the best corn is from that planted on level, with a planter, and hence no raised hills. It will be seen that this method leaves the roots in a way less likely to be disturbed, and as a plant taking on such rapid growth needs a multitude of rootlets it grows faster if they are not injured.



Root of potato at three inches high.

Next in interest, perhaps, comes the potato. The early sprout every farmer is familiar with, hence it is of the single potato plant, when three or four inches high, before there is any attempt to "set," as it is termed, (when the new tubers begin to show themselves) that I speak. You can readily see that the roots tend downward, and the plant is shaped like a hill, as you might say. Hence as it is deep rooted as it advances from the stalk, hoeing would be different in effect from what it would to hoe corn; hence potatoes grow faster by hoeing, and yet they are so sensitive in their nature that if hoed just before they set and an extra growth of tops stimulated, it is at the expense of the tubers, and the yield is injured. Unlike the corn plant, the roots do not much extend after the tops blossom and the tubers set, but they develop tubers, which perhaps in some way aid the action of the roots, as they stimulate the tops to extra exertion. In a large crop of tubers the tops are sometimes so taxed that the seed falls off before ripe, or in other words the more productive varieties develop tubers to the detriment of seeds, and hence the saying that potatoes do not ripen seeds as formerly is true. I trust the farmer will study the fibrous roots of all the plants we pass in review, that he may better understand how to supply their wants, and especially to avoid the dangers in fertilization which I shall soon point out.

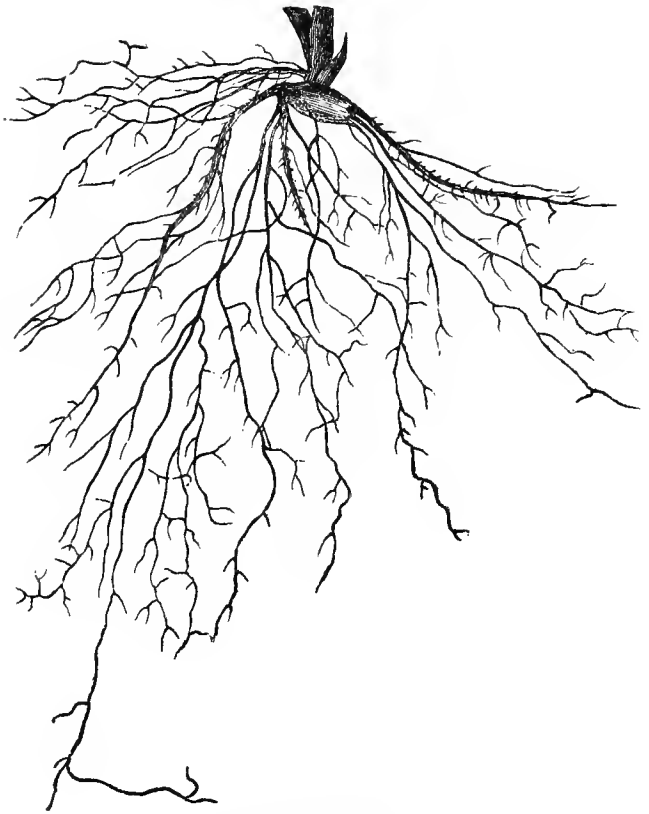


Root of herds grass.

In the line of grasses, perhaps the one of greatest interest is the timothy, or herds grass. This is the grass most admired in New England, and perhaps is the most hardy in our variable climate. It will be seen from the above representation (which as I desired to show the bulb in sufficient size does not represent the full length of root), that there are secondary branches. At F, you will see them represented, and it is a peculiarity of this plant that all the rootlets at the end branch as at F; and those secondary branches branch also at their ends, and thus the little mouths are immensely multiplied.

Those roots, by means of the little hairs upon their sides, take in nourishment, but by far the larger share is taken in within an eighth of an inch of the very end; hence the more terminations the greater the feeding power of the plant. The stalk bulb may be seen at E. As all well know, the blossom and leaf buds upon our fruit trees set in August, for the ensuing year; so the herds grass sets its stalk bulb in autumn, which lives through the winter, producing the seed stalks of the ensuing year. This is why timothy meadows cannot be closely fed in autumn without injury. If this new stalk is bitten off after the set for the ensuing year it lets in water, which injures the bulb by freezing, and the top of the bulb will be killed and hence fail to produce the seed stalk the coming summer. For this reason meadows thus fed will produce perhaps a short, thick grass, but the heads will be scattering and short, also. I hear farmers say of such fields that they are "bound out;" a more proper expression would be "fed out." If from any cause this gets too much of a start in autumn it is also killed in the same way, as will be further spoken of when we speak of fertilization.

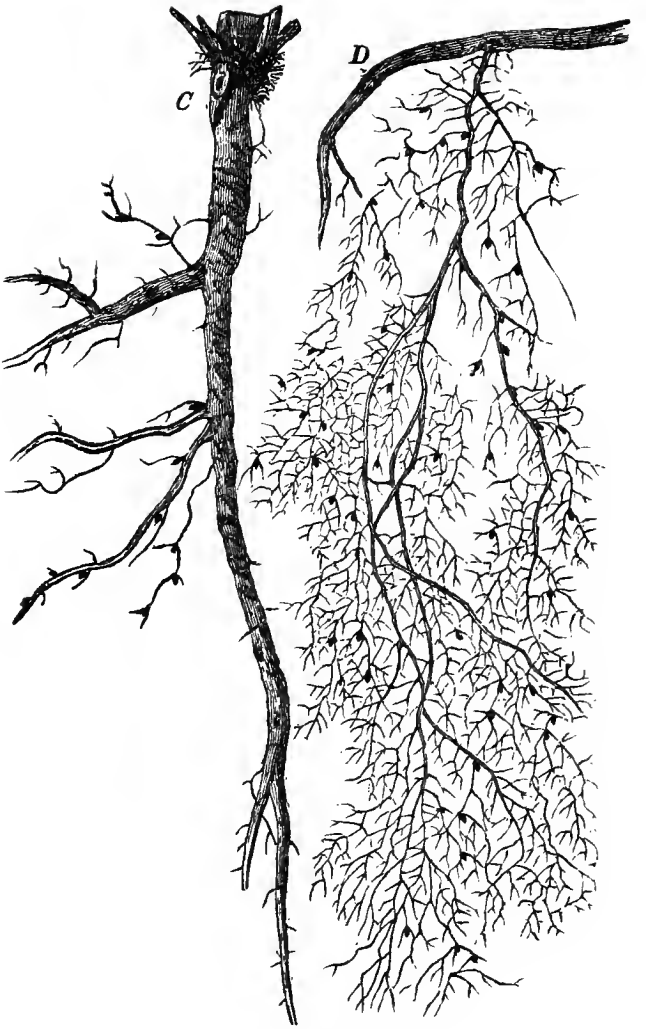
Somewhat similar to this is the oat, the root of which is here shown,



Root of the oat.

but it is different in its capabilities. It throws out many feeders all along the line of roots, sometimes in bunches as well, feeding the plant vigorously until past blossom; they then die, leaving the roots nearly inactive, and the kernel is ripened by the nutrition in the straw. From this it is reasonable to infer that cutting before quite ripe, or as soon as full in the dough, would both improve the straw and kernel, as it would complete the process of ripening in the shade, and as the root does nothing would improve upon the wetting and drying process, from dews, rain, etc., which injures the straw in the same way it does grass when cut, and all know washed hay both less palatable and nutritious. For this reason the root does not sprout, as it is literally dead, its whole power of nutrition being exhausted. Yet it has the appearance of life, as the subdivisions of the stalk which send out the little rootlets are still green.

Quite different from this is the root of the clover. As we see it when pulled up in the ordinary way it looks like the root represented at C, but when carefully washed out it is found to be one of the most beautiful and intricate roots of the field.



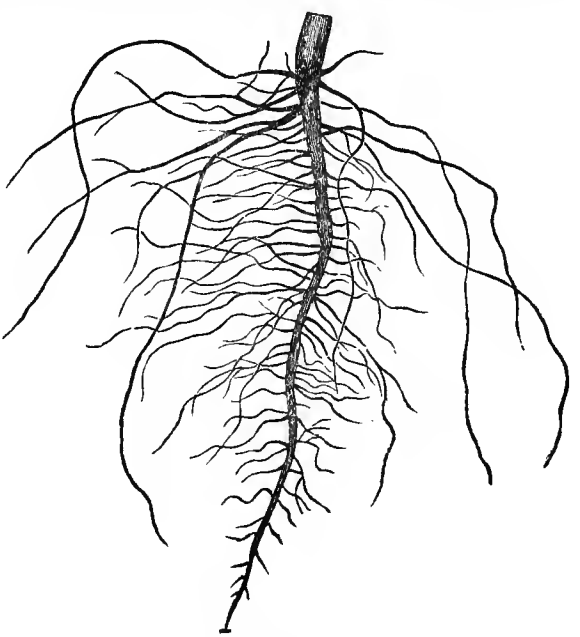
Clover roots.

At D may be seen one of the branches of rootlets which are so numerous and extensive that they usually extend several feet—sometimes several yards, and permeate the soil so completely that it would seem nothing could escape them; little tubers are also quite abundant, and under certain conditions reproduce the plant, yet are usually killed when the roots are with ice and freezing, but aid in spreading the plant when all is vigorous. They also, in my opinion, act as storehouses of nutrition, aiding the ripening of the seed, etc., but different investigators have different views. Be it as it may,

while most of our cultivated plants can gain no nutrition below where the atmosphere can penetrate the soil, the clover can; as by experiments I have found a root capable of sustaining a plant after passing through five inches of solid clay into an alluvial soil below where the roots expanded extensively. Every other plant tried, failed to push rootlets through the clay. Yet this, while it shows what clover can do, does not as fully show that other plants cannot, as it is only negative testimony in the experiment.

As clover has a fleshy root, full of nutrition, it is doubtless the best plant to use for green manuring, but often hard to get rooted on soil not in good condition; and I find if the seed is wet and mixed with fine bone dust it will greatly aid it in taking root, even if no more than fifty pounds of dust be used to the acre, if that is wet and fully mixed with the seed so as to adhere when sowing.

There are other peculiar rooting plants. One is the bean family. It will be seen from the cut that it sends down a tap root,



Root of bean.

and all the rootlets are thrown out as branches. It has, however when carefully washed out, a very large root for the size of the plant; and when we think of the great weight of beans that may be gathered from so small a plant we can readily see the need. They often extend deep into the ground and supply a complete network of branchlets.

After looking thus far into the root formation of plants, let us see what the roots do. We have already stated that they have little mouths whereby they take food, but they are so small that they can admit nothing unless it is fully dissolved in water, and as this solution to our senses must be very weak indeed, so much so that we are inclined to call it pure even, it will be seen that to get a little of what the plant desires it must distill much, which is in reality true. The amount of water thus evaporated through the aid of vegetation much exceeds our expectations. Though it is a familiar fact that the leaves of plants exhale moisture few consider how much. Hales, the earliest accurate observer of whom we have record, found a sun flower, whose foliage had thirty-nine square feet of leaf surface, evaporated or distilled through its leaf pores three pounds of water daily. A cabbage, with a leaf surface of nineteen square feet, exhaled as much as the sunflower with thirty-nine square feet; thus showing a very large difference in the power of different plants. Schleiden found every square foot of grass sod to exhale one and one-half pounds of water every day. But I have found that a clover sod exhales at least twice and a half as much when in vigorous growth, and another observer, Schubler, states that he has found pasture grass to exhale five and one-half pounds to the square foot daily. The bean in Knop's experiment exhaled about one half the entire weight of the plant each day, and the Indian corn even more than that; and various grains and grasses exhale more than their weight each day. Let us think of this. Think how there is taken out of the soil of our meadows three tons of water daily for a good crop, or ten tons for a corn crop when in full growth, and you will see that one of the great requirements is water. Water enough to dissolve the plant food needed, and when we think that our hardest minerals and most solid rocks are gradually worn away by this very water, and then think how small an amount of food from the soil is necessary for the growth of a plant that may take from ninety-five, to ninety-nine per cent. of its substance from the atmosphere and does take more than ninety-five per cent. from that source in all cases; and what farmer may not be encouraged by the small amount of such food he need supply. Then when he divides this small amount into nine parts and becomes assured that at least half of these will never be in part even exhausted; and in the poorest Vermont soil that it is probable no more than one or two are partially exhausted, he can at once see how little he has to supply. Yet that little is just as necessary as the little cog, on the least wheel of his watch, is to it as a timekeeper. Without all the wheels and cogs it can never be a perfect watch, and without all the ingredients necessary to the plant we cannot have a perfect plant. But you may say, how do we know what to supply? The chemist talks of substances which we do not understand; what do we need? I will tell you. We need no spoken language; we need no articulate sounds; we need no chemist with his mystic charges, and ruinous bills to pay; we need only the silent plant given by God, for man's benefit, and the soil in which we wish to cultivate it. In that soil we will put the seeds of what we wish to raise. It is all a mystery. We cannot

understand the little germ that produces the plant. We no more can understand the method by which it takes its food, yet we know it feeds; and sixteen years ago, when I first commenced my experiments on plant growth, I had many theories which seemed reasonable, and I believed them; but I have seen some of them flatly contradicted by the plant, and all modified more or less. It is true I understand it better. It is true that by patient search with the microscope, days of toil and investigation have lent aid, until I have been able to perfect crops at small expense, compared with days gone by; but I do not for a moment believe that I have reached the end of investigation, and I am very sorry to give you only partial results from yet unfinished experiments.

From the foregoing remarks you have doubtless anticipated the fact that as plants require so little and so largely reduced solutions, that the tendency is to fertilize our land too much, or if not too much as a whole too much at a time, and not often enough. Upon this in my opinion rests the great secret of success in agriculture.

Many a man supposes he cannot manure too heavily. But with the investigations I have made upon the rootlets of plants, I find if any fertilizer is too easily soluble or put on in excessive amounts, that while we may get better crops than we should without it, we could do much better by using less. All farmers know that a small amount of salt is beneficial on our Vermont soils, but all equally well know that a slight excess will injure the crop, and much will kill it. Now what is true of salt is just as true of all fertilizers. All farmers know that the water that leaches from a manure heap will kill grass if strong, and if as much was applied to the whole farm he knows it would destroy all crops. Now I have found that a crop may be injured with kindness and yet not destroyed. If the water in contact with the little mouths of the rootlets is too strongly impregnated even with food they are killed, and so much of the capability of nourishment of the plant is cut off. Hence if the fertilizer, let it be what it will, is in bunches in the soil, many plants are injured by it while others grow much better, because where the lumps or piles are, rain dissolves too much, and the rootlets there are destroyed, while others may be deprived of what they need. Hence you see how necessary it is to have your fertilizers and soil perfectly mixed.

Again some materials may be put upon the soil that are not themselves plant food, yet their action may be very beneficial. They may by their effect release plant food already there, from the soil, or by forming new combinations, liberate the same; or they may simply like charcoal dust hold plant food by absorption, to be given up when the plant demands it.

Hence the range for experiment is very great. Now for the test system. Let us measure off our soil, into as many plots as we wish to try experiments on, (one tenth of an acre is a very good size), and to have them long and narrow I find best, with at least three or four feet between them. Let us put on carefully and evenly broadcast, on the ground, which has been carefully prepared for the seed, such fertilizers as we decide to experiment with; let it be yard manure, ashes, bone dust, plaster, superphosphate, salt, guano or humus, as

the case may be. As our plants feed largely near the surface, let the food be there. After the fertilizer has been placed, harrow lightly if you choose, or let it remain as sown. The idea that what you desire will evaporate is as fallacious as that your maple sugar will go off from your sap by evaporation. Cultivate as usual and note the results. Without further troubling the reader I will say that I have tried numerous experiments in various ways, manuring at all seasons and noting the results, and from those experiments I deduce the following statements, that on my land seem to be facts:

That if we desire the best possible crop we must fertilize every year, but never enough to lodge our crops.

That we usually fertilize too much, especially with nitrogenous fertilizers, as they are but little needed.

That the amount necessary should be carefully determined by experiment.

That on all ordinary land three good loads of stable manure to the acre, applied in the winter, will furnish all the nitrogen and most other fertilization that is needed for a three and a half ton hay crop, and alternate years ten bushels of ashes, or 200 pounds of plaster (if beneficial,) in place of the manure; this on my land is amply sufficient. I presume it to be so on most land where potash is needed.

I find that with the exception of ashes, the best time to fertilize is in the winter on the snow. I must again refer to the rootlets for my reason.

I find with grass as with trees the plants prepare themselves for winter. Now if you fertilize in the fall there is likely to be rains and warm days; the plant food dissolved from your fertilizer runs into the soil stimulating the mouths of the little rootlets to action, and they force an abnormal growth too late in the season, and the new rootlets formed are almost sure to be destroyed by the frosts of winter, and the entire plant very much weakened. If your fertilizer is put on when all the roots are locked in frost, the plant food is dissolved by spring rains and carried to them just in the time of need, and they awaken to a perfect and rapid growth, and the snow water and the rain distribute the plant food more evenly than it can be done by the lesser rains of summer.

Of all seasons I find the spring time, when fertilizers are usually applied, the poorest, as there is not sufficient rain to dissolve and render them available. It cannot be perfectly distributed and it comes to the plant in irregular supplies, more so than at other seasons, and the consequent damage to the rootlets is very great. While we obtain a benefit, it is scarcely one-fourth what we ought to get from our outlay.

I have now a word about chemical fertilization. I do not condemn it. Such fertilizers are useful but they cost too much. The manufacturer usually prepares them in such a way that they will benefit all lands; hence a large majority of farmers not only pay for what they do not need, but for what injures them, more or less, though the benefit may be the greatest. For example: a farmer needs superphosphate of lime; under that name he buys a so-called super-

phosphate that contains, and he pays for it, ten dollars' worth of nitrogen per ton. He puts it on corn; the nitrogen is not needed —it actually damages his crop ten dollars to the acre, or, as he will put his ton on perhaps five acres, he is damaged fifty dollars and pays ten dollars for that damage. His soil requires the superphosphate, and had he bought in such form as his land needed, he would have been benefitted perhaps one hundred dollars by it, but the nitrogenous material which has damaged him makes it doubtful whether the fertilizer he bought has paid cost.

So he discards commercial fertilizers without reason. If he buys a pure superphosphate and his land requires it he usually uses too much, or puts it in the hill, or does not distribute it evenly, and does not get the benefit he ought.

Moderately speaking, one ton of fine ground bone (dust) has, in my experiments, been worth more than any four tons of such superphosphates as I have been able to purchase, and that, too, used without any preparation. But in my experiments I have found the following simple formula costing, according to circumstances, from eight to ten dollars per ton, the best of anything I have used.

FORMULA.

Take two hundred pounds of bone meal (dust), the finer the better. Sift, if you can get a fine sieve, so as to save one hundred pounds of the finest. Put the coarsest part of it into a tub or box, and wet with water so it is moist; it will take three or four pails full; then slowly add two gallons of sulphuric acid, which weighs at least fourteen pounds to the gallon. Stir continuously. It will foam and boil; let it stand twelve hours, then add another gallon of acid as before, and while it is hot, so the lumps break easily, add the other hundred pounds of bone meal. This will then weigh about three hundred and fifty pounds; add to it immediately sixteen hundred and fifty pounds of dry loam, woods dirt, muck, or if inconvenient to get, you may add sand, though I like woods dirt or muck best. This of course has been previously pulverized and sifted; should you choose, put all together, mix perfectly, and you have a ton. It has cost you about eight dollars and, as far as my experiments go, and others that have tried the same say, it is equal to any ton of nitrogenous fertilizer used.

I use about two hundred pounds of this to the acre and find it as good as any fertilizer I ever used costing $45 per ton. I find it better than bone cut with sulphuric acid until it contains fifteen per cent, of soluble phosphoric acid, such as Prof. Sabin in his addresses has put down as the most valuable superphosphate.

I arrived at this formula by experiments, against reason, as a chemist would say; but as I have explained, it is just the mixture that is acceptable to the little rootlets of various plants. Next to this I find from seventy-five to one hundred pounds of bone dust to the acre, without any preparation, only to mix with dry woods dirt so it can be evenly distributed, say one hundred and fifty pounds of dust to five hundred pounds of loam, and then apply broadcast, as before, putting this amount on two acres.

ANOTHER FERTILIZER

which I have found of superior value has been made from bones and ashes, and where potash is needed is very valuable. Take old bones and burn them, if you please, so they will crush easily, or fill them into a barrel whole, tamping in, in alternate layers double their bulk of hard wood ashes. Put them in the cellar so as not to freeze, and wet down now and then, as much as you can without leaching, and at the end of a year take into the barn floor and mix with muck or loam as most convenient, so that you can evenly spread over as many acres as you have barrels of bone and ashes. Bone meal can be treated in this way and used in two months after. Use in same way as the bones. The bones will be fine and all right as the meal if they have the year for it.

If I did not otherwise use salt in my fertilizers I think I should add a bushel of salt to a ton of this mixture.

Plaster may also be added to the bones previously cut with acid, according to the first formula, but not with the ashes in the last.

SOLUBLE SUPERPHOSPHATES.

If you desire a soluble superphosphate such as the best that can be made from bones (not best for the land as I find, but best from a chemical standpoint), it can be made as follows:

Take 200 pounds of bone dust and 80 pounds of commercial sulphuric acid, which is about six gallons, yet it sometimes requires nearly eight gallons, as the acid will not be standard. Moisten the bone meal as in the first formula, and add the acid slowly, and when the bone is dissolved, having stood 24 or 36 hours, it can be dried, if water is in excess, by any dryer you choose; but the bone dust is the best, and you have a superphosphate that will contain about 14 per cent of soluble phosphoric acid. There is no trouble in making it; not half the trouble there is in making soft soap, and yet if that is wanted, and you can be sure you get what you purchase, it may be as well to buy it.

WHAT IS SUPERPHOSPHATE?

I have often been asked this question, and so answer by telling what I suppose the farmer wants to know, though it does not exactly answer the question, but I will try and tell you in language that may be understood, something of it.

Phosphate of lime, as it is found in bones, is composed of one atom of phosphoric acid and three atoms of lime. The so called superphosphate is composed of two atoms of water, one atom of lime, and one atom of phosphoric acid.

The first is insoluble in pure water, but slowly soluble in water containing carbonic acid. The last is soluble in pure water.

To convert the insoluble into the soluble we in reality have to take away two atoms of lime. Now sulphuric acid in chemical language has a stronger affinity for lime than the phosphoric acid has. So it has the power to take away two atoms or parts of the lime, and you

have left all the phosphoric acid, but it has united with the remaining one atom of lime and two atoms of water, and in that new form is easily dissolved in water.

The sulphuric acid has taken two atoms of lime unto itself, and that new combination is sulphate of lime, called also gypsum or land plaster.

Either of these new compounds are harmless to seeds, and can be drilled in with them. If your bone dust was made from raw bones it will still contain nitrogen in small amounts, but not enough to injure seeds, or at least I have not found them injured by it. If made from steamed bones it is doubtless better, yet the difference is so slight that it is not observable in bone dust usually purchased, as bones cannot be easily made very fine unless they are boiled, steamed or burned at least in part.

If you should wish to reduce bone meal fully, I believe it most easily done by mixing in the following proportions: 40 pounds bone dust, 30 pounds water, and 30 pounds sulphuric acid. First mix dust with the water, then add the acid slowly, and dry with woods dirt or finely sifted loam 12 hours after mixing.

I wish every farmer, however, to bear in mind the fact that the insoluble phosphate of lime, though not soluble in pure water, is slowly soluble in water containing carbonic acid; and as the soil contains considerable carbonic acid, the rootlets of the plants do, as I find by experiment, get the phosphoric acid desired from the insoluble bone dust, and with a small percentage of soluble phosphoric acid, according to the first formula, and a larger per cent of insoluble, the plants mature much better in my experiments, and so I ask all to try for themselves and see if I am not right about it. See if you cannot get more actual advantage from one ton costing ten dollars than you can from one ton costing forty-five dollars. If you can you have thirty-five dollars more profit. Is it not worth your trials? If you fail you have not lost. If you find it as I have, it gives you the highway to success. Some soils may require more than mine does and some less; this you can easily ascertain by plot experiment. But remember that too much not only costs more than it should, but does you actual injury by giving you unhealthy rootlets, and hence damage to the plants.

This damage may appear by the plants lodging, rusting, forming imperfect kernels, or in a drying off rather than ripening, which gives you shrunken grain or seeds.

Remember a lodged crop is always a poor one, or at least if your soil was perfectly fertilized it would not lodge. I have this year weighed off three and two-thirds tons of merchantable hay per acre, composed of herds grass and red top, from several acres of my land, treated by the previous formula, without its being lodged. Red top heads could be found one foot long, and herds grass heads eight and a half inches. The grasses were in perfection, made so by the fertilization I have spoken of. So it is no myth, but absolute certainty.

NITROGEN.

It is conceded that if we buy a fertilizer of any grade in the market we should have what it contains at market value, and what Vermont farmers desire to purchase is usually phosphoric acid and potash. To this list is added in most advertisements nitrogen. Nitrogen is by far the most costly ingredient, and yet has at most a very doubtful value. With me it never paid half its cost, and many times injures the crop materially. J. W. Sanborn, farm superintendent of the New Hampshire Agricultural College in 1879, found his corn crop diminished by its use, and in 1880 materially injured by it. He writes Prof. Atwater of the Wesleyan University, that in his experiments he finds it "worse than useless," and that the experiments show more unfavorable results every year they are repeated.

In the Connecticut Agricultural Report of 1880 and 1881. in reference to nitrogen Prof. Atwater says:

"The experiments are numerous and decisive enough to warrant the inference, that, as corn is commonly grown, nitrogenous fertilizers in any considerable quantity would be rarely profitable." In other cases they show an increased crop, but not sufficient to pay the cost of such a high priced fertilizer; rarely it does pay its cost, and sometimes a small percentage of profit even. Yet I am of the opinion that the less of it I have the better.

But you desire to know the form in which it comes to you. Perhaps in your experiments the sulphate of ammonia will be the best form to use. But in commercial fertilizers it is often supplied by fish cake, or from flesh of animals that die, or other decomposing animal refuse. I am told it is sometimes done by adding the liquor which comes from the steaming of bones, using that instead of water to wet the bone meal with. These methods of course give the fertilizer a very disagreeable smell. Prof. Collier says of it when speaking of the same:

"That the condition of the valuable constituents which are present in fertilizers emit no odor whatever; although an idea seems to prevail among many farmers that a fertilizer is not worth much unless it smells bad. This offensive smell which is given off by many fertilizers, good and bad alike, is of itself exceedingly undesirable, and of no value whatever as evidence in deciding between different fertilizers, since it arises from animal matter present in the mass, and which are added for the nitrogen they generally contain through often in very small quantity."

SOURCES OF ERROR.

All farmers are aware of the increased growth of crops, especially the grass crop, in wet weather, but most farmers have noticed that hay grown in wet weather shrinks badly when cut, and that bulk for bulk it does not feed as much stock, and their loads do not weigh as heavy as in dry seasons. The reason is, the plants have large hollow stalks, and the growth contains very much more water. Artificially the same results may be brought about by fertilization. De

Saussure observed that plants growing on a dry lime soil contained less water than those from a loam.

Ritthausen gives a statement from experiment upon clover raised on good sandy loam that is very conclusive. The field was divided into four plots with soil and sod all in the same condition, and one plot was fertilized with plaster, one with ashes, and two left without any fertilization. Off from the plot manured with ashes the green crop weighed 14903 pounds, when dry 5182 pounds.

Unmanured,	12880	"	"	5418	"
Manured with plaster,	22256	"	"	4800	"
Unmanured,	18815	"	"	5190	"

Yet the plots fertilized were taller, darker green, and looked better than the unfertilized.

The same was true of corn which I fertilized with nitrogen, six years ago. It was taller, looked darker and better, but produced less amount of corn and less dry stover than the same land where no nitrogen was used.

My experiments with sulphate of lime (plaster) and with ashes have, however, given me much better crops; yet the shrikage in drying has been in greater proportion than on the plots not so fertilized, but the experiments of Ritthausen as well as my own, in connection with Prof. Atwater and others, show the necessity of actual weight and measure in determining results; and I trust all will experiment with like exactness so that their results become at once intelligible and reliable. The eye being often deceived, it makes it necessary that the scale should determine all results, and a written record book in which all experiments are entered is also indispensable. It matters not how good a memory a man may have, he cannot carry on a series of experiments from year to year and derive all the benefit therefrom that he can if he keeps a full written record.

For more full information, I would refer all to the late agricultural reports of Connecticut, where numerous experiments showing widely different results are reported; yet the inevitable conclusion must be that the farmer need not buy much if any nitrogen or nitrogenous materials for fertilizing his land. As that is the most costly ingredient which has been supposed necessary to proper fertilization, it will be seen that by the use of such materials as I have urged for your consideration, and the judicious use of the manures about the farmyard, it will not need to be purchased. The saving of purchase money will be something, and the increased value of crops that produce well and do not lodge, will be much more.

PRICES OF MATERIAL.

I condense from Prof. Goessman's report the following on prices of the material used in fertilizers. As the consumption of commercial fertilizers is still increasing from year to year throughout the entire country, the tendency of a gradual but steady rise in the cost of various kinds of crude stock used for their manufacture is a noticeable feature in the history of the trade. The prices of the

potassa and of the nitrogen in particular have been higher than in previous years, whilst those of the different forms of phosphoric acid have remained as a general rule more stationary. The higher grades of potassium chloride (muriate of potash) have brought a higher price, whilst the kainits and the higher grades of potassium sulphate have been sold at previous rates or for less. A continuation of this condition may have its effect in the future on the composition of the compound fertilizers to meet their customary retail market prices per ton, by lowering their nitrogen percentage, and increasing that of phosphoric acid. The lately reduced importation of genuine Peruvian guano, as well as the smaller supply of Menhaden fish refuse, has no doubt exerted a serious influence on the entire trade, and may in part at least account for the increased cost of all our ammoniated superphosphates. I have taken particular pains to obtain at various times during the past year, until quite recently, reliable market reports from Boston and New York. A digested abstract of the information obtained in this connection will be found here. The figures in that price list refer in either case to the cost of the articles delivered at the respective local railroad depots, in case of cash payments. As the cost of distribution must vary more or less in each case, it has, for obvious reasons, been left to the good judgment of the consumer to decide whether in his own locality the price asked for the fertilizer he bought is a fair one. According to the best information obtained, it seems quite admissable to expect in the retail trade in the majority of instances, an advance of from twenty to twenty-five per cent above first cost at the works.

During the past year the following prices may be considered a fair basis for the valuation of the essential constituents of fertilizers; only *specified* forms of the *guaranteed composition* have received a particular consideration in the valuation; and in case of inferior mechanical condition of the fertilizers the customary lower rates has been adopted:

	Per pound in cents.
Nitrogen in form of nitric acid	25
Nitrogen in form of actual ammonia	26
Nitrogen in form of animal matter	24
Soluble phosphoric acid	12.5
Reverted phosphoric acid	9
Insoluble phosphoric acid	6
Potassium oxide in muriate of potash	5
Potassium oxide in kainit	5
Potassium oxide in high grades of sulphate of potassa	7

It is well for farmers to consider that the manufacturers are only obliged to furnish the lowest percentage guaranteed in their statement of composition; and that the insoluble phosphoric acid in many of our ammoniated superphosphates consists of fine ground mineral phosphates, which are less efficient and consequently less worth than that in the form of bones and of animal and vegetable matter.

	Price per pound in cents.
I. Nitrogen. In form of nitric acid	25
In form of ammonia	26

In form of dried ground meat and blood, finely pulverized steamed bones, finely ground fish guano, Peruvian guano, urates, poudrettes, and artificial guano	24
In form of finely ground bones, and bat guano	22
In form of fine ground horn, wood dust, etc	15
In form of coarsely ground bones	18
In form of horn shavings and woolen rags, human excretions and barnyard manure, fish scraps, animal refuse matter from glue factories and tanneries, etc	12
II. Phosphoric acid soluble in water as contained in alkaline phosphates and superphosphates	11.5
In Peruvian guano and urates	9
In form of so-called reduced or reverted acid	9
In precipitated bone phosphate, steamed fine bones, fish guano, according to size and disintegration from	6.—6.5 to 8
In form of bone black waste, wood ash, Caribbean guano, ground bone ash, coarsely ground bones, poudrette, barnyard manure, etc	4
In form of finely ground South Carolina and Nevassa phosphate	3
III. Potassium oxide. In form of muriate of potash or chloride of potassium	5
In form of sulphate of potassa in natural and artificial kainits	5
In form of higher grades of sulphate of potassa	7. to 7.5

NAME OF MATERIAL.	Price per ton of 2,000 lbs. in dollars.		Price per pound in case of from 100 to 200 lbs., in cents.	
Sulphate of ammonia, containing from 24 to 25 per cent of ammonia	95 to 105		4.75 to 5.5	
Nitrate of soda (Chili saltpetre,) containing 95 per cent of that componnd	75	80	3.75	4.5
Nitrate of potassa, containing 94 to 96 per cent of that compound	166	170	9	9.5
Dried blood, yielding from (a) 15 to 17 per cent of ammonia, (black),	65	75	3.5	4
(b) 12 to 14 per cent of ammonia, (softired),	55	60	2.75	3.25
(c) 10 to 12 per cent of ammonia	45	50	2.25	2.75
Dried meat, yielding from 14 to 15 per cent of ammonia	50	55	3	
Castor pomace (ground), yielding 5 to 6 per cent of ammonia	25	30	1.5	2
Cotton seed meal, yielding from 7 to 8 per cent of ammonia	33	55	1.75	2.25
Fine ground bone (steamed), yielding from 3.5 to 4.5 per cent of ammonia, and containing from 50 to 55 per cent of bone phosphate	38	45	2	2.5
Bone black (waste material), containing from 30 to 34 per cent of phosphoric acid	30	35	1.75	2
South Carolina phosphate (ground), containing from 25 to 28 per cent of phosphoric acid	20	25	1.25	1.5
Navassa phosphate (ground), containing from 25 to 28 per cent of phosphoric acid	20	25	1.25	1.5
Canadian spatite (ground), containing from 30 to 35 per cent of phosphoric acid	30	35	1.5	2
Superphosphate of lime, containing from 15 to 16 per cent of soluble phosphoric acid	30	35	1.5	2
Acid phosphate, containing from 12 to 14 per cent of soluble phosphate acid	25	30	1.5	1.75
Lobos guano, yielding from 4 to 6 per cent of ammonia, and containing from 18 to 20 per cent of phosphoric acid	55	60	3	3.5
Peruvian guano (guaranteed), yielding from 6 to 8 per cent of ammonia, and containing from 12 to 14 per cent of phosphoric acid	60	65	3.25	3.5

Muriate of potash, containing from 80 to 85 per cent of that compound, equal to from 50 to 53.7 per cent of potassium oxide	42	45	3	
Muriate of potash (Douglass hall), containing 80 per cent of that compound, equal to 50 per cent of potassium oxide and about 10 per cent of sulphate of magnesia	45	50	2.5	
Sulphate of potassa, containing 80 per cent of that compound, which is equal to 43.3 per cent of potassium oxide	65		4	
Sulphate of potassa, containing from 60 to 65 per cent of that compound, which is equal to from 32.3 to 35 per cent of potassium oxide	55	60	3.5	
German potash salt, containing from 28 to 32 per cent of sulphate of potassa, which is equal to from 15 to 17.3 per cent of potassium oxide	18	20	1.25	
Kainit, low grade, containing 22 to 26 per cent of sulphate of potassa, which is equal to from 11.9 to 14 per cent of potassium oxide	12	15	.75	1
Sulphate of magnesia (kieserite), containing from 60 to 70 per cent of that compound	20	25	1.25	1.5
Sulphate of magnesia, containing from 50 to 55 per cent of that compound	14	16	.8	
Fine ground gypsum, containing from 95 to 98 per cent of that compound	9	10	.5	

ANALYSIS OF FERTILIZERS.

The following analyzed fertilizers are those generally met with in the State. The analysis was conducted by Prof. A. H. Sabin, chemist of the Agricultural College at Burlington. "The samples for analysis were purchased by farmers in different parts of the State, and by them sent to the laboratory."

ANALYSES.

Bradley's XL. Superphosphate.

Total phosphoric acid (P 2 O 5)	11.18	per	cent.
Soluble phosphoric acid	6.93	"	"
Reduced phosphoric acid	2.25	"	"
Insoluble phosphoric acid	2.	"	"
Total nitrogen	2.	"	"
Potassium oxide	2.	"	"
Loss by drying	3.8	"	"
Sand, etc	8.83	"	"
Organic matter	72.19	"	"
	100.00	"	"

Soluble Pacific Guano.

Total phosphoric acid	10.91	per	cent.
Soluble phosphoric acid	4.85	"	"
Reduced phosphoric acid	4.08	"	"
Insoluble phosphoric acid	1.98	"	"
Total nitrogen	3.11	"	"
Potassium oxide	3.03	"	"
Loss by drying	3.	"	"
Sand, etc	11.1	"	"
Organic matter	68.85	"	"
	100.00	"	"

Darling's Animal Fertilizer.

Total phosphoric acid	13.37	per	cent.
Soluble	1.	"	"
Reduced	6.37	"	"
Insoluble	6.	"	"
Total nitrogen	4.55	"	"
Potassium oxide	2.92	"	"
Loss by drying	10.53	"	"
Sand, etc	3.	"	"
Organic matter	65.63	"	"
	100.00	"	"

Stockbridge Corn Fertilizer.

Total phosphoric acid	10.46	per	cent.
Soluble	3.75	"	"
Reduced	4.31	"	"
Insoluble	2.4	"	"
Total nitrogen	5.88	"	"
Potassium oxide	.39	"	"
Loss by drying	16.8	"	"
Sand, etc	12.2	"	"
Organic matter	54.27	"	"
	100.00	"	"

Stockbridge Potato Fertilizer.

Total phosphoric acid	9.17	per	cent.
Soluble " "	3.75	"	"
Reduced " "	4.52	"	"
Insoluble " "	0.9	"	"
Total Nitrogen	2.94	"	"
Potassium oxide	.76	"	"
Loss by drying	18.5	"	"
Sand, etc	3.9	"	"
Organic matter	64.73	"	"
	100.00	"	"

Stockbridge Onion Fertilizer.

Total phosphoric acid	4.99	per	cent.
Soluble " "	3.65	"	"
Reduced " "	.64	"	"
Insoluble " "	.7	"	"
Total nitrogen	3.5	"	"
Potassium oxide	8.16	"	"
Loss by drying	19.01	"	"
Sand, etc	2.74	"	"
Organic matter	61.60	"	"
	100.00	"	"

Bowker's Hill and Drill Fertilizer.

Total phosphoric acid	8.68	per	cent.
Soluble phosphoric acid	6.85	"	"
Reduced " "	.98	"	"
Insoluble " "	.85	"	"
Total nitrogen	3.08	"	"
Potassium oxide	1.45	"	"
Loss by drying	16.78	"	"
Sand, etc	3.72	"	"
Organic matter	66.29	"	"
	100.00	"	"

The valuation of these, according to accepted standards, per ton of 2000 pounds is as follows:

Bradley's XL. Superphosphate.

138.6 lbs.	of soluble phosphoric acid	$17 32
45.0 "	reduced " "	4 05
40.0 "	insoluble " "	2 40
40.0 "	nitrogen	8 40
40.0 "	potassium oxide	3 00
Total		$35 17

Soluble Pacific Guano.

97.0 lbs.	of soluble phosphoric acid	$12 12
81.6 "	reduced " "	7 34
39.6 "	insoluble " "	2 38
62.2 "	nitrogen	13 06
99.9 "	potassium oxide	7 49
Total		$42 39

Darling's Animal Fertilizer.

20.0 lbs.	of soluble phosphoric acid	$ 2 50
127.4 "	reduced " "	11 47
120.4 "	insoluble " "	7 20
91.0 "	nitrogen	19 11
58.4 "	potassium oxide	4 38
Total		$44 66

Stockbridge Corn Fertilizer.

75.0 lbs.	of soluble phosphoric acid	$ 9 37
86.2 "	reduced " "	7 76
48.0 "	insoluble " "	2 88
117.6 "	nitrogen	24 60
7.8 "	potassium oxide	58
Total		$45 19

Stockbridge Potato Fertilizer.

75.0 lbs.	of soluble phosphoric acid	$ 9 37
90.4 "	reduced " "	8 14
18. "	insoluble " "	1 08
58.8 "	nitrogen	12 35
15.2 "	potassium	1 14
Total		$32 08

Stockbridge Onion Fertilizer.

73.0 lbs.	of soluble phosphoric acid	$ 9 12
12.8 "	reduced " "	1 15
14.0 "	insoluble " "	84
70.0 "	nitrogen	14 70
163.2 "	potassium oxide	11 24
Total		$37 05

Bowker's Hill and Drill Fertilizer.

137.0 lbs.	of soluble phosphoric acid	$17 12
19.6 "	reduced " "	1 76
17.0 "	insoluble " "	1 02
61.6 "	nitrogen	12 94
29.0 "	potassium oxide	2 17
Total		$35 01

The St. Johnsbury ground bone was examined only so far as to find it to be pure bone meal; it contains insoluble phosphoric acid to the amount of about $27, and probably nitrogen to the amount of about $10 or $12.

It is, however, rather coarsely ground, and would be much better if it were finer.

In looking over these figures, it must be remembered that insoluble phosphoric acid is of comparatively little cost, and the nominal value of the fertilizer, so far as phosphoric acid is concerned, is to be found by looking to the amount of soluble and reduced acid. From the published reports of other analyses of some of these fertilizers, it would seem probable that the amounts of phosphoric acid give a fair index of the comparative values of these as manures. In several of these, perfectly clean, sharp sand was found, but as the analysis shows, not in very large quantity. The amount of moisture was found in another sample from the same bag of Darling's Animal Fertilizer to greatly exceed that given, but the general appearance of the sample indicated the smaller amount as the more nearly correct. In all cases of highly ammoniated manures the amount of loss by drying is liable to include some ammonia; it is, however, doubtful if it does in any of these cases."

This valuation is, of course, according to the ingredients contained in the fertilizer, and does not tell the farmer what he needs. The kind that figures the highest might not be worth to the farmer five dollars per ton—in fact might injure his crop; while the lowest valued one might be actually worth to him double its cost.

As I have before said, it is as necessary in feeding plants as it is animals that their needs must be first consulted. You do not need buy salt for cattle fed on salted hay, or buy it either as a fertilizer to put on a salt marsh. See to it that you first, by the plot system, ascertain your wants, and then you can easily and cheaply supply hem.

NOTES ON INSECTS INJURIOUS AND BENEFICIAL.

BY HIRAM A. CUTTING, PH. D.,
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APHIDES.

Insignificant as may be a single aphis these insects, known as "plant lice," are a pest everywhere that man cultivates, and may be even considered injurious wherever plants grow.

They are also prolific almost beyond belief. As a rule insects lay eggs, which hatch, pass through the larval stage, then the pupa, and at last, after days or weeks, become perfect insects. But plant lice, while they now and then lay eggs, and put up with the slow process which is so fashionable, go as a general rule on a different plan—retaining the egg and expelling impregnated females alive.

A female aphis takes her place upon a branch, say of the young shoot of the apple tree; plunges her beak into the tender bark and sucks sap. After a short time she begins to produce her young at the rate of twelve to fifteen each day. These young are just like their mother, and follow in her footsteps, getting their growth in a few hours, and produce fresh young. As to the opposite sex it is no business of theirs. Wood says he "wonders why the Shakers do not adduce the aphides in support of their peculiar tenets." The extent to which this remarkable increase can be carried may be imagined when investigation has shown that a single female, isolated from the opposite sex, has produced impregnated females that have gone on in a direct line of production, in the same way, for four years.

It is in consequence of this remarkable mode of production that the twigs and buds, as well as leaves, become so rapidly covered; the quickly-succeeding generations crawling over the backs of their predecessors so as to find an unoccupied place to drive their beaks. Thus it may be seen how a rose bush may have scarcely a plant louse upon it on Monday, and yet within the week be so covered that no bud will expand, or growth be made. It is the same with the hop; hence the first appearance of the louse causes the gravest apprehensions, as, if the days are cool or windy or showery so as to drive away the insects that feed upon the louse, a few days will ruin the crop. Of these enemies I will soon speak.

Those who have examined the aphis, whether winged or not, have noticed that towards their tails there were two slender projections. These are tubes through which the insect forces a sweet fluid.

When trees are covered with the aphis, upon the leaves in the morning may be found drops of sweet liquid, called honeydew. It is this exuded fluid from the aphis, and it attracts bees and flies, and often bees collect enough of it to injure, if not destroy, the flavor of their honey, as this honeydew has a strong, acrid taste that burns in the throat after eating it Such trees are also overrun with ants which lick the sweet droppings from the leaves, and hold high revels on this substance—the origin of which, to many, seems so mysterious. But the ants go further than this. Not content with the sweet upon the leaf they anticipate its fall and lap it off when exuding. Neither do they stop here; but as man stables and herds his cows for milk, so does the ant the plant louse that he may obtain the sweet. They carry them bodily to their own nests, were they provide for them much the same as we do for our cows, using bits of thistle root and other succulent vegetation to feed them upon.

This fact has been long known, but the notion of ants keeping milch cows seemed so far beyond the capacity of an insect that many persons refuse to believe such a romantic story. In substantiation of what I know to be true I copy a letter published by Rev. J. G. Wood, in his "Insects at Home." He says:

"Another odd station for aphides is on the roots of plants. I have found them by hundreds on a thistle root, closely packed together and almost as white as snow. The other day I pulled up a large thistle that grew on an ant hill, and thus I brought to light a whole colony of aphides. I had long known the great value which ants set on those little 'beasts,' so I shook down some dozens of them from the thistle root among the ants, which were all a-swarm with the damage I had done their dwelling. No sooner were the ants aware of the presence of the aphides than they began to fondle them with their legs, somtimes positively taking them round their necks to tap them on their back with their antennæ, and to lick them with their tongues. They then took hold of them with their jaws and lifted them from the ground, and carried them with the greatest care into the recesses of their nest.

"I walked by the same place three hours later; all was quiet and orderly about the nest and no aphis could be seen. So I went to work with my knife and scraped down the side of the hill; I soon came to the aphides. They were clustered together on little bits of thistle root which had been broken off by the ants. They were attended by numbers of the ants, who, finding their cattle in jeopardy, drew them gently from the roots and carried them further into their nest."

Mr. Newman, a celebrated naturalist, says he has cut open apple after apple to find the core filled with them, or the seeds covered. There was no way for them to get in which he could discover. There was no chance of their getting air through an inch of pulp, and more, they soon died after exposure to the air, showing that it did not agree with them. How they could get there is a subject of specu lation. Now for

A small ichneumon-fly uses them as hatching houses for its eggs, the ants are often seen protecting the aphides from its attacks. As soon as one has been stung, she leaves her feeding ground and crawls to the under side of a leaf and there fixes herself. Her body soon swells so as to be round as a shot; she dies, and soon the young ichneumon pushes himself out of the body, making thus his escape into the world. These dead and empty skins may ever be seen in abundance upon an infected tree. The

LADY BUGS,

Fig. 1. Lady Bug.

Belonging to the family *Coccinellidæ*, are not only things of beauty, but they are among the great benefactors of civilized man, and preserve many a harvest which, but for their aid, would be a hopeless loss.

Few people would suppose when looking at the larva of the Lady Bug what was his real condition of life. It looks as harmless as you can imagine any insect to look, and as though he would be more likely to be eaten himself than to eat others; yet he is such a ruthless destroyer of the plant louse, that if but few of them be put upon an infested plant in a day or two not an aphis will be left.

The mother Lady Bug lays her eggs in packets among the aphides and as soon as the young insects hatch they commence feeding on the plant lice nearest them, and as they gain strength, keep on tours of destruction until the branch is free from the lice. Next in its destructive powers come the little

GOLDEN EYE.

Fig. 2. Golden Eye.

A fine name for a fly so small, yet the eye is like bright gold, and its wings so beautiful; and yet it is so common it hardly attracts attention, and is called by the naturalist *Chrysopa Vulgaris*, or Common Golden Eye (see Fig. 2). But it does not come into life as such a fly, but as a worm, which cares only for food; it is eat, eat

all the time, and the food is the plant louse. As this little worm eats out the juices it covers itself with their skins, and this droll covering protects it from its enemies. For about two weeks it goes on thus, then spins its cocoon of silk, and comes out of that in due time a beautiful green fly, with the golden eyes which give its name. Under the microscope those eyes are very beautiful, and seem to be made up of emeralds, rubies and diamonds, sparkling and changing all the time. It is sometimes called the Lacewing Fly, on account of the peculiar delicacy of its wings. No fly takes more pains to provide for its progeny. It selects a perfect leaf in a secluded part of the plant where it drops a small drop of a white substance, which the mother draws out into a stem near half an inch long; and on the top of this stem it places the egg and cements it on. They place large numbers of these eggs together, so the leaf looks as though it had a little forest growing upon it, and some very good investigators described the forest of eggs as a species of parasitic plant, supposing the eggs the seed cups of the diminutive moss. (Fig. 2).

But notwithstanding those insect friends man sometimes need combat the louse, especially in gardens. Carbolic acid soap suds and a syringe are usually efficacious. Tobacco-water is also death to them. Smoke they do not like, and the fly powder (*pyrethrum*) is destructive to them. In Europe they often rub them off with a brush, when on rose bushes or valuable plants. The only trouble is they do not stay killed, as their capability for increase soon makes up their loss.

Fig. 3. Fig. 4.

Fig. 5. Clothes Moth.

THE CLOTHES MOTH.

Our common clothes moth (Tinea flavifrontella) is of a uniform buff color, with a silky iridescent lustre, the hind wings and abdomen being a little paler. The head is thickly tufted with hairs and is a little tawny, and the upper side of the densely hirsute feelers (palpi) is dusky. The wings are long and narrow, with the most beautiful and delicate long silken fringe, which increases in length near the base of the wing.

This is the description given by A. S. Packard, Jr., yet there are several allied species which have much the same habits, except the construction of cases, but they eat carpets, clothing, and various

other things about a house, like grain, articles of food, paper, objects of natural history, etc.

There are several successive broods in a season, and slovenly houses are often overrun with them. Very many do not recognize these moths in their perfect stage they are so small, being about a third of an inch only, while they often vent their wrath upon those large millers that fly about lamps on warm summer evenings. But these large millers are as innocent of any harm to our woolen clothing as can be, though they may be guilty of mischief in our gardens. The moth as we despise it, is a little pale, delicate worm, (Fig. 5) about the size of a darning needle, and perhaps half an inch long, with a pale horn colored head, and a ring next to it of same color. It has sixteen feet, but the first six only well developed, and in almost constant motion to draw its slender body in and out of its case. Its head is armed with a formidable pair of jaws, with which it cuts its way with great ease through any woolen fabric.

The case (Fig. 4) is really the most remarkable feature in its history, and is formed of little bits of the fabric it eats, joined together with the finest silk, and constructed into a tube or case nearly round, but flattened slightly in the middle and contracted just a little at each end. Both ends are always kept open. This he takes with him wherever he goes, as it is his house, made to live in. But he feeds voraciously, cutting without care for damage here and there, leaving his hole behind him. But his house gets too small; he applies his shears to it, cutting it open at each end, and putting in a piece with such perfect care that the joints can hardly be seen, even with magnifying power. He thus finds room to grow until he is mature, when he goes into his pupa state as seen at (Fig. 3.) The pupa is considerably curved and rounded. At first it is nearly white like the worm, but just before its exclusion of the moth it is the color of varnish. The torn cases are often seen. What is most wanted is the

REMEDY,

whereby we may save ourselves from loss by their depredations. These are many, and all are doubtless effective with careful hands. Dr. T. W. Harris states that "black pepper powdered and put under the edge of carpets will repel moths."

Tight cedar chests or closets are safe places for fabrics likely to be injured.

Camphor gum and carbolic acid are good preventives. Pyrethrum powder under carpets or sprinkled upon them is said to be effectual.

If a carpet or fabric of any kind be injured and the moths and eggs already there, they may be killed by a careful ironing with a hot flatiron. Such ironing becomes more effectual if a damp cloth be used between the iron and carpet, as the steam permeates further and more quickly than the dry heat of the iron.

THE TIGER BEETLE,

or "Cicindela," is well named, for it represents among insects the same character and ferocious habits that the tiger does among beasts. They are also dressed in gay colors and have elegant forms. The number of species is very great, and yet as they befriend man instead of doing him injury they have been closely studied. They are usually of some shade of green with metallic and purplish reflections, and marked with brilliant or light colored dots and short curved lines. These beetles abound in sunny paths, and breeds on the sandy shores of rivers and ponds. The larva (Fig. 6) is a hideous fellow, with an enormous head and immense jaws, armed with teeth on the inside, and a horn on the ninth segment of the curved body, which ends in a hook, which gives it a grotesque and ugly appearance.

Fig. 6. Larva of Tiger Beetle.

The hook aids it in climbing out of its deep hole, in which it lies in wait for weaker insects. The holes are sunk perpendicular in the sand, and have no loose particles of sand or dirt about the opening.

The occupant may be drawn out by putting a piece of straw into the hole. and the angry insect will fasten to the straw. The more common forms are the "Cicindella generosa" (Fig. 7) or common tiger beetle, the "Cincindella hirticollis" (Fig. 8) or hairy necked tiger beetle, "Cincindella sex guttata" (Fig. 9) or the six spotted tiger beetle. The last is often found in shady places not frequented by the other species.

Fig. 7. Tiger Beetle.

Fig.8. Hairy-neckedTiger Beetle.

Fig. 9. 6-spotted Tiger Beetle.

THE WATER BOATMAN.

This is the wonder and delight of all children, as they move so lightly and prettily upon the water as they row over the surface in pursuit of insects upon which they feed *Notomecta undulata* is the scientific name for those most common through New England (Fig. 1).

Fig.. 10. Water Boatman.

What attracts the attention of the young investigator is the ease with which this boatman takes aboard his supply of air to breathe, when he dives to the bottom. The deck of this boat (which means the under side of his body as he swims on his back) has a ridge in the middle and a depression between this and the edge of the body, is bridged over from the head to the end of the abdomen by a layer of coarse, oblique hairs, and a layer of less oblique hairs arise on each side, frome the middle of the ridge. These hairs form what we might call a false upper deck. Now when he rises to the surface for air, he projects the end of the body slightly out of water, the air passes up on each side along the tunnel under the hairs and collects in bubbles above the base of the legs. Along this tunnel are six pairs of spiracles (breathing tubes) into which the air passes. When taken out of the water these breathing tubes are easily seen. Often the air bubble he takes with him covers the whole under side of the body, and in the water he looks as though he carried a globule of quicksilver. It is reported that they can sting, and like a bee their sting is armed with poison. Such is not true, but he can bite, I assure you, and the pain from the bite is as severe as from a bee sting, and it is reasonable to suppose he secretes a poison, which benumbs the insects he preys upon; but as no sack for any such secretion can be found, it is believed to be his saliva which must be an active poison.

Another singular insect is the

WATER SKATER,

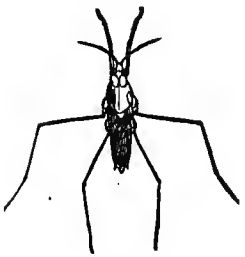


Fig. 11. Gerris.

called "Gerris poludum," and is commonly seen running over the surface of streams and pools, marvels of mechanical skill and activity. This insect is sometimes called the "Wherryman," and it seems that thousands of years ago he anticipated the racing boat and wherries. Nature is full of wonders, but before we leave the insects that live about the water we must speak of the

DRAGON FLIES,

of which "Diplax Berenice" is a fine representative.

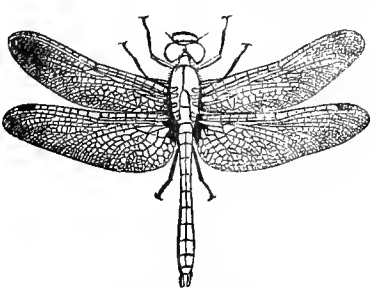


Fig. 12. Dragon Fly.

Here we have an insect type of all that is savage, relentless and blood thirsty. From its birth to its death, which is about one year, in all its changes whether larva, pupa or imago, it is literally a pit fall for luckless aquatic insects. But when in its imago or perfect state it is ever on the wing in pursuit of prey, and revels in gluttony and carnage.

We call it then "Devil's darning needle," very likely on account of its unblushing and rapacious character. Could he tell us the tales of his life, rapine and murder surpassing the age of fable would be revealed, but aside from his ugly name which is often a terror to children, he is not injurious to man, but his whole life is benificent. He is indeed a scavenger of no mean ardor, and his gay livery and

beautiful wings challenge our admiration and he gains respect. He preys largely upon mosquitoes and the larva of equally noxious insects. During his four weeks above the waters he is a continued good to man, never doing harm.

But look at his enormous head with its jutting brows, retreating face and heavy under jaws; all eyes and teeth, and such a hunch-back, long legs that look as though shrunken by disease, a very fiend of the air and yet our friend. Let us never judge by appearances.

This dragon fly lays its eggs on rushes or weeds at the surface of the water, where they are hatched by the warmth of the sun. The larva is very active, and a great feeder. His jaws are covered as it were with a mask to disguise its ugly mouth from his prey, but woe to the insect that gets within reach of his hooked jaws. It is easy to rear them in an aquarium, but their long life tires out the observer; and not so much is known of their life in the water as we could wish. There are several species of this insect.

Another peculiar fly is the

FORCEPS TAIL,

or *Panorpa rufescens* (Fig. 13).

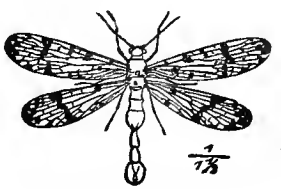


Fig. 13. Forceps tail.

This, similar, to the species just described, is a great scavenger. The males are armed at the extremity of the body with a peculiar forcep like apparatus as seen in the cut. They are the friends of man, and may be found about bushy fields, shrubbery, etc.

Fig. 14. Pirates.

Another valuable aid to the farmer as he causes the death of immense numbers of Caterpillars and noxious insects is the

Fig. 14. It is a kindred of his that destroys so many bed bugs in Europe, and it is said that the pirates are not afraid of them.

I will now tell you of some of the enemies of the ten-lined potato beetle (*Doryphora decemlineator*). Of course all must be interested as it makes a saving of our time in fighting them to have insect aids.

Fig. 15. 9-spotted Lady Bird.

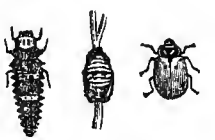


Fig. 16. Hippodamia.

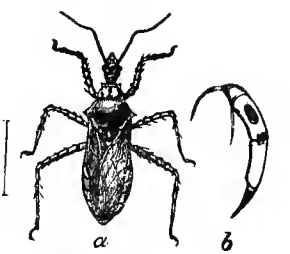


Fig. 17. Many-banded Robber.

ENEMIES OF THE POTATO BEETLE.

The lady birds—*Coccinella* 9 *notata* and pupa (Fig. 15), *Hippodamia* 13 *punctata*, larva and pupa (Fig. 16), destroy multitudes.

The eggs of the lady birds are very much like those of the potato beetle in color, but are smaller, and not so many in a cluster, but always laid in close proxity to those of some other insect. As soon as they hatch they commence their war of extermination, and, as they are voracious feeders, they follow it up almost unceasingly. This lady bird is about two-thirds the size of the potato beetle when fully grown, of a yellowish red color, with two or more black markings on each wing-cover, being shorter and more thick set than the potato beetle. In fine, they are about the size and the shape of a half pea. (See Figs. 15 and 16). There are several varieties, but all are the friends of the farmer, and should have special protection.

So of the many banded robber, *Harpactor cinctus* (Fabr.), Fig. 17. It is ever actively on the lookout for food, and woe to the potato beetle that falls into its sharp claws.

Fig. 18. Spined Soldier Bug.

So of the spined soldier bug, *Arma spinosa* (Dallas), Fig. 18; *a*, its beak; *c*, the beak of the *Enschistus punctipes* (Say), both mag-

nified, which closely resembles the *Arma*. Doubtless, both species do a great work, as they are wholesome depredators, not alone upon the potato beetles, but upon many farm pests.

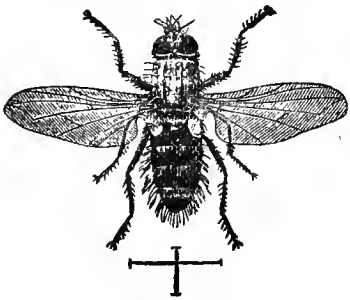


Fig. 19. Lydella.

There is also a parasitic fly (Fig 19) *Lydella doryphoral*, that not only destroys myriads of the larvæ of the potato beetle, but also those of many other pests. The marks at the bottom of the cut denote its actual size.

This is the only insect yet known that lives parasitically on the potato beetle, but such is its voracity that Mr. Riley found it destroyed fully ten per cent of the first brood and over fifty per cent of the third brood of the potato beetle. For the last year those enemies gained quite an advantage, as the less number of early beetles indicated.

There is also another deadly foe in the *Philonthus*, which Dr. Packard found to creep even into his hatching-cases and kill not only enough for food, but all; just as the weazel or mink will kill more chickens than they need for food. This beetle is black, with short wing cases, and is, perhaps, the most terrible enemy of the Colorado beetle. It is a member of the family *Staphylinidæ*.

There are, perhaps, no natural enemies that will entirely kill them out, and so, like the farmers at the west, we are inclined to Paris green or London purple.

THE BLISTERING BEETLES. *Cantharidæ*

Fig. 20.

Fig. 21.

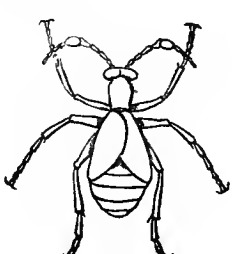


Fig. 22.

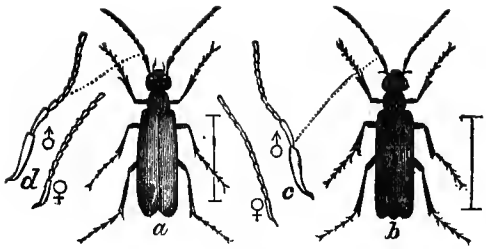


Fig. 23.

These beetles are also great eaters of the potato plant. For several years they have done great damage in New England, but only in special localities. They have not become general. Those most injurious are the striped Cantharis, *Lytty vittata* (Fabr.), Fig. 20, the margined Cantharis, *Cantharis marginata* (Olivier), Fig. 21, the ash-colored Cantharis *Lytty cinerea* (Fabr.), Fig. 23, *a*, male, and the black Cantharis, *Lytta murina* (Leconte), Fig. 23, *b*; *c* and *d* show the magnified antennæ of the male and female, rendering it easy to distinguish them. These beetles, while they make short work of the potato leaves, when abundant, are not very fastidious about their food. They will eat beets as soon as potatoes, and also pig weed, or almost any kind of green leaves when the potatoes and beets fail.

There is another species, being a species of oil beetle, *Meloe augusticollis*, Fig. 22, which when plenty are a great foe to potatoes, tomatoes, beets, and various other vegetables; but they are vulnerable to insect enemies, and so are only now and then abundant. They may be killed by Paris green as the potato beetle, but cannot be picked off, as they are too spry for the fingers.

Druggists are indebted to the insects of this order for the "Spanish fly," so called, which is used for blistering, and is in reality one of the blessings in medical practice. Thus we are often indebted to the humblest creatures for our greatest boons. To the ant we are indebted for the discovery of chloroform. How this came about is well told by Dr. Lankester:

"Some years ago, whilst editing the correspondence of John Ray, I was amused by the letters which passed between this great naturalist and Dr. Martin Lister of New York, on the subject of the 'acid liquid of pismires.' It had been observed that whenever ants were bruised their juices afforded an acid secretion, which substance was afterwards known as formic acid. The attention of modern chemists being directed to formic acid, Dumas discovered that it contained a base, a compound radical, which he called formyle. This, with three atoms of oxygen, forms the formic acid. Now Dumas not only found this out, but he further discovered that the three atoms of oxygen might be replaced with three atoms of chlorine. He thus obtained terchloride of formyle. It so happened that, when ether had been employed as an anæsthetic, Dr. Simpson of Edinburgh was induced to look for some agent that might act even more beneficially than ether in this respect. He tried the terchloride of formyle, and found

it to succeed; and this is the agent which under name of chloroform, has been the means of alleviating a vast amount of human misery; and if occasionally it has destroyed life it has saved so much that mankind owes a deep debt of gratitude to those who have successfully introduced it into practice."

THE MOSQUITO.

Who has not watched the sluggish pool or even the barrels of stagnant water that many a farmer keeps under his eaves, and seen the tiny mosquito leap off from her little boat which was the cast off skin of the chrysalis in which she spent her early life beneath the waters? As she sails away in the light of the fast departing sun, she presents a movement full of ease and grace, quite unsurpassed by her dipterous allies. Suppose she draws near you, and with the softened melody of her wings views the subject of her coming banquet? She settles on your hand, folds her wings, and daintily sets down one foot after the other, unfolds her lancet of marvelous fineness and of wonderful complexity and fitness, and lifting one foot she drives it into the skin through bleeding capillaries and shrinking nerves. Then she sips the nectar of life, and while she is so doing let us suppose she is under the microscope, and we are examining her head and lancet-like arrangements as seen at Fig. 24. To use the description of Packard "The head is rounded with the two eyes,

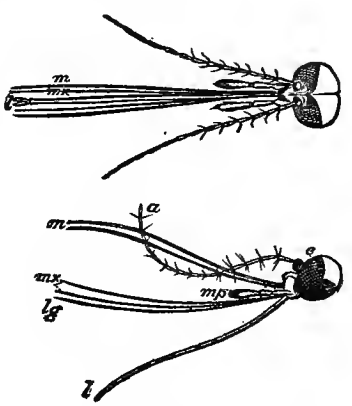


Fig. 24. Mosquito's head.

occupying a large part of the surface, and nearly meeting on top of the head. Out of the forehead, so to speak, grow the long delicate hairy antennae (a), and just below arises the long beak which consists of the bristles like moxillæ (mx with their palpi mp) and mandibles (m) and the single hair like labrum, all which five bristles like organs are laid in the hollowed labium (l).

Thus massed into a single awl-like beak the mosquito, without

apparent effort, thrusts them into the flesh, and by aid of the sucker-like expansion of the end of the labium draws in the blood through the channel formed by the five bristles and their sheath. Her body may be seen filling with blood until her appetite is satiated, and she flies slowly away, frequently to die as a result of her gluttony In a moment the place of the bite begins to itch, and in those susceptible to the poison it is often almost intolerable sometimes a serious matter. Multiply this mosquito by thousands, and no wonder they are a pest indeed. Hence men avoid their haunts as they would the haunts of hornets.

But let us return to their larva (Fig. 25, A), which is found in pools, ditches, tubs, and everywhere where water is still and partially stagnant. They remain at the bottom, feeding upon decaying matter, thus doing a little good to help compensate for their faults, and perhaps to show that nothing is made in vain. The larva inhales air through a single respiratory tube (c), situated near the tail. When about to transform into the pupa state it contracts and enlarges anteriorly near the middle, the larval skin is thrown off, and the insect appears as at (Fig. 25, B).

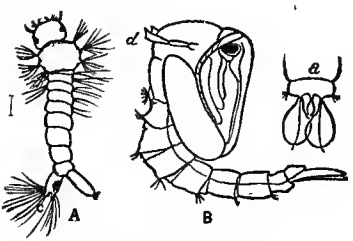


Fig. 25. Larva of Mosquito.

The head and thorax are massed together, the rudiments of the mouth parts and wings and legs being folded upon the breast. There are now two breathing tubes, *d*, situated upon the back instead of the tail, which ends in two broad paddles, *a*, so that it comes to the surface head foremost instead of tail first. This position accords better with its increased age and experience. In a few days it is born into its imago or perfect state, as described, and its wings expand for its marriage flight. The males are beautiful, as the good ever are. They do not bite. They are more retiring than their strong minded partners, and are very seldom seen in our dwellings, but live quietly and honorably in the woods, where they may be found if sought, but they never seek you. They may be easily distinguished as they have bushy, feathered antennæ.

The female lays her eggs in bunches, upon the water; they float about and soon hatch to go through the metamorphosis spoken of. Like other flies they grow in the larval and pupa state, and after they acquire wings they do not grow, so the small midges are not young mosquitoes, as some think. But how we can get along with them is the question. If you go into the woods hunting or fishing you can disgust them by using a solution of carbolic acid and oil of tar.

After this has been applied they will look you over to see if they can find a place where that is not, but they refuse to eat if that is there. Carbolic soap also answers a good purpose, and if used before you retire, by washing yourself with the suds, it is said to prevent the bite of the flea and bed bug, also.

CABBAGE WORM. *Pieris Rapœ*

Fig. 26.

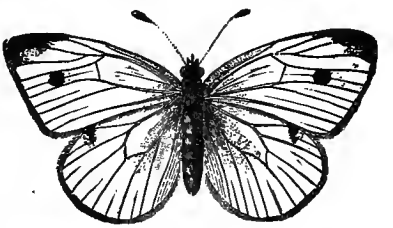


Fig. 27.

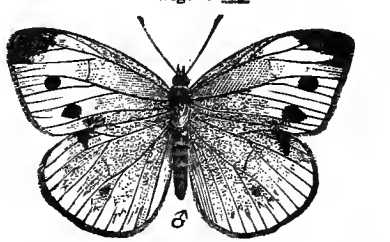


Fig. 28.

Fig. 27, butterfly of the cabbage worm, male. Fig. 28, female. The female is distinguished from the male by having two round spots, rarely three, on the wings. The body of this butterfly is black above, with white wings. *a*, cabbage worm; *b*, chrysalis.

This worm, the product of the rape butterfly, is the great pest of the cabbage grower, and doubtless the worst of all our imported insects. It was imported from England to Quebec in 1857, as it is supposed, with a quantity of cabbages; but it was so sparse that none were seen until 1859, and so rapid was its increase that in 1864 it had extended at least forty miles in every direction from Quebec, and it was estimated that it caused the loss of a cabbage crop that would have sold for at least $250,000.

In England and Europe it is the butterfly everywhere common; its larva is the dread of every cook, as she expects to cook several with every cabbage, notwithstanding her utmost care. Its chrysalides are so abundant in the winter time that they seem present upon everything that affords them the least protection; even upon the doors of dwellings in constant use several may often be found. America had two native species, which sometimes appeared upon the cabbage, but they were content with the outside leaves; but while this important species riddle the outsides leaves, they secrete themselves in the head also, and render it necessary to pull the same to pieces before cooking, and then you are not sure, for many times

they appear cooked with the leaf. The color is so near that of the leaf upon which they feed that they are ever liable to appear as unwelcome visitants. The use of cabbage among all is rapidly decreasing from this cause. It has already spread over large sections of the country, being taken in Vermont in 1866, in Maine in 1868, and around New York and Boston in 1870. It is now almost as widespread as the cabbage is cultivated.

The butterflies have their bodies black above, with wings white, as may be seen in the cuts.

The female may be distinguished from the male by having two round spots, rarely three, instead of one as in the male, upon the front wings. Underneath both sexes are alike, and have two spots on each front wing, but none on the back ones, which are usually yellowish, yet sometimes with a greenish tint. They vary much in color, but the above general description will be sufficient to enable one to recognize them, as the first impression will be white or nearly so, and the slight variations of tint, from yellow to green, will not be likely to much confuse.

This butterfly deposits eggs upon the leaves of the cabbage, usually upon the under side. They are exceedingly beautiful when magnified, having a delicate tint, variable as in the butterfly, and seemingly etched with a beautiful network of lines. The larva, as seen in the cut at *a*, is pale green, finely dotted with black, with a yellowish stripe down the back, and a row of yellowish spots along each side in a line with the breathing holes. As the stripes and spots are somewhat obscure, some farmers do not notice them, and think they have another variety, which is possible, as we have two native species that sometimes feed upon the cabbage, but they are sparse in numbers, and seldom seen in Vermont.

When about to transform, it leaves the plant upon which it feeds and takes shelter under the rails of fences, in stone walls, or any place convenient, and changes to a chrysalis, which, though variable in color, is usually pale, green, speckled with minute black dots, as seen at *b*.

The second brood pass the winter in this condition; this species, like our native ones, having two broods a year.

The first remedy that occurs to most when they see their cabbages destroyed is to quit raising them, and starve them out. This cannot be, as they feed upon several plants, and even upon the willow, when other food is not at hand.

The first method of attack is to cover the young plant with mosquito netting, held off from the leaves by sticks, usually four of them, set in the ground, and a piece of netting pinned on. This is done in various ways, according to the tact of the person doing it, and, when properly done, prevents the eggs being laid upon the leaves, and so the cabbage grows in security. This costs, besides the labor, from one to two cents for each cabbage.

If this is not done, picking the eggs is the next method. They can be easily found, and, if attended to, they may all be destroyed. Children can easily do this, and are usually led to do it by the promise of a small reward for any certain number found. When the but-

terflies are seen about your garden they can be easily caught in a net, as they are slow, lumbering fliers, and easily killed, thus crushing hundreds of eggs without hunting for them.

If the eggs have not been destroyed, poultry, if in numbers, will pick off most of the worms, as they are considered by fowls as a sweet morsel, very desirable. But we cannot fully depend upon them to do the work, though they will help greatly. As they get into the very heart of the cabbage head, hand-picking will not amount to much more, but yet it will decrease their numbers so that cab bages can be raised.

Carbolic soapsuds are destructive to them, and if not too strong will not injure the plant. Fine sawdust impregnated with carbolic acid is one of the best things for their destruction. Superphosphate of lime, fine salt, ashes and lime have all been used with effect, yet nothing of the kind is sure to kill all the worms. Close attention to the plant, or perfect protection by netting, as first spoken of, is the sure way to secure a crop of cabbages.

If, as estimated, at least half a million dollars' worth of cabbages were destroyed by it around New York city alone, last year, and an average of two hundred and fifty thousand dollars' worth are annually destroyed around Boston, Montreal and other cities, it shows beyond question that we have, in spite of our warfare upon it, an implacable foe.

We have thus far but one insect that lends us substantial aid. This is a species of chalcid fly, and so rapid has been its work that of one hundred and ten chrysalides, collected by F. W. Putnam of Salem, Mass., at least two-thirds were infested, and brought forth chalcid flies, instead of cabbage butterflies. In most sections, how ever, this help has not yet arrived, but will become general, doubtless in a few years.

By placing boards elevated a few inches from the ground about your cabbages, the worms will select these places for their change to the chrysalis state; and as those infested by the chalcid fly can be easily distinguished by the livid and otherwise diseased appearance of the body, and left to produce flies, while the healthy are destroyed, you can aid your friends and destroy your enemies. If the chrysalides are all found healthy, you can make a general destruction.

Hot water poured upon the plant is recommended by some; but the plants will only stand water at 140° without injury, and that will not kill many of the worms.

One of the most effectual remedies is the insect powder (Pyrethrum). It can be diluted with flour at the rate of one ounce of the powder to five ounces of flour, and dusted over the infested plants.

Another recommended by several the past season consists of equal parts of saltpetre and salt dissolved in water and sprinkled over the plant. Should sprinkle it on at about 140 degrees of temperature. The quantity of the salts is one great spoonful of each to ten quarts of water.

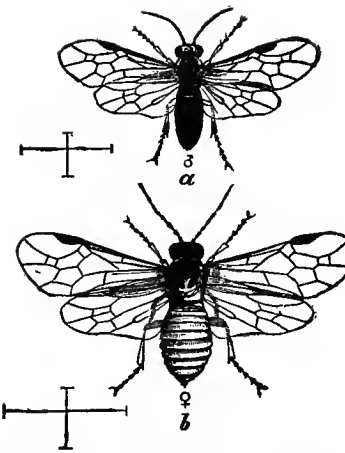
Paris green, London purple, or white hellebore will, of course, kill the worms, but should seldom be used, as it will lodge in the

growing head and endanger the lives of those making use of the cabbage. Dust sprinkled on it is also effectual, but will leave grit in the head so as to injure it for eating, yet is without danger. London Purple is the least dangerous, and may be used diluted with flour before the heads begin to form, without any danger. Cayenne pepper is also a severe dose for them, and harmless if used late in the season. It may be diluted with flour.

Dr. Hoskins, of Newport, raises many cabbages, and he is of the opinion if you plant early and use close heading varieties, you may let the worms do their worst and you will get good cabbages. They wouldn't look very well growing, and so I should recommend the use of some death to worms.

THE CURRANT WORM.

Nematus ventricosus. KLUG. *a, a, a,* different stages of growth; *b,* a single segment of the caterpillar magnified.



Adult specimens enlarged. The marks at the side represent the actual measurement with wings spread. *a*, male; *b*, female.

This worm is so common and so well known in Vermont that it needs no description. It affords an excellent example of the wonderful rapidity with which an important insect may increase and flourish in this country. It was imported from Europe in 1860, into nurseries in Rochester, N. Y. Since that time it has not only spread eastward throughout New England, but to the far west. It is a dreadful pest to the currant and gooseberry bushes, and in sections where it has been left to do its work unchecked such fruits are numbered as things of the past.

Though near fifty species of the *Nematus* are natives of this country, this little foreigner has forced himself so disagreeably to our notice that we almost forget the ravages of the native varieties.

Though the worm is so well known, the fly that causes the mischief is seldom noticed. The female is of a bright honey-yellow color. The head is black, with all the parts below, as well as between, the origin of the antennæ, except the tip of the jaws, a dull honey-yellow. The antennæ are brown black, often tinged with reddish above, except toward the base, and beneath, entirely dull reddish, except the two basal joints. They are four-fifths as long as the body; the third joint, when viewed sideways, is four times as long as wide; the third, fourth and fifth joints slowly diminishing in length. On the thorax are four conspicuous black spots and other smaller ones. The legs are bright honey-yellow; the hip joints whitish, with the extreme tips of the hind shanks, and the whole of the hind toe joints are blackish brown. The wings are glossy, with dark veins, and expand a little over one-half inch. It is stated in the *American Entomologist*, that in Europe she is known to lay eggs which have not been fertilized, and from them young caterpillars are hatched. It is probable, however, that they do not have the power of again propagating the race, and that the eggs hatch

and the worms eat is just as likely as in the case of the silk-worm and other moths, as well as of some insects, including the honey-bee.

The male (Fig. 21, *a*) is rather smaller and is black. The head is dull honey yellow. The antennæ are brown-black, often a little reddish beneath, except toward the base; they are as long as the body; while longer than in the female, they are also somewhat flattened out. The under side of the thorax and abdomen are honey yellow.

I have given this minute description of the fly, as, if seen and killed, hundreds of the worms may be saved. The eggs are laid about the 20th of May in Vermont, in regular rows, along the under side of the veins of the leaf, at the rate of about two a minute. The embryo escapes from the egg in from four to ten days, and immediately commence feeding. They continue their work upon the bushes until they are bare of leaves, and then, whether fully grown or not, go down into the ground and form little black pupæ, varying in size according to the way the worm is fed. Emerging in about two weeks, they lay their second brood, which pass the pupa state in in the ground, as before but do not emerge until the following spring. The fly lives about nine days.

For their destruction, we first look to the birds. While a few only will catch the fly, none are found to eat the worm. Thus we are deprived of our most powerful ally. We never half realized the good done by insectivorous birds until we have an enemy they disregard. Among the natural enemies of this pest are three kinds of ichneumon flies, of which one is an egg parasite. From this aid three-fourths of the eggs are destroyed; but the other fourth give us much trouble.

The first method of destruction is to pick off the worms and destroy them. This, if there are but few bushes, can be done quite easily, and is really the most practicable method.

The next in use is to dust on the leaves powdered white hellebore from a muslin bag. Used in this way it is not sufficiently poisonous to render dangerous the use of the fruit. This is recommended by Walsh and Riley.

A solution of a pound of copperas to six gallons of water has been used with success. It blackens the leaves but does no injury to them. Suds made of carbolic soap may be sprinkled on from a common sprinkler. Any dust that touches them is lodged in the spiracles or breathing pores, and soon produces death. Dust from the road, dried fine plaster of Paris, or any finely pulverized substance will answer. The Grafton fertilizer, which was finely pulverized quartz, was the best material I ever saw for killing them. It possessed the requisites of great fineness and perfect dryness, so it would make a dust easily.

Pulverized slate is excellent, also the insect powder "Pyrethrum" before spoken of. It can be largely diluted with flour, and has the advantage of not being poisonous.

Gum aloes are, when fine, equally penetrating, and less dangerous than the white hellebore.

By a little attention in time this pest can be easily stayed by

any of the means spoken of, but *The Boston Journal of Chemistry* says this worm can be immediately destroyed by the use of carbolate of lime. This is certainly less costly and more agreeable to use than the hellebore, so to those who must buy something to use, instead of using road dust I would recommend it. With two or three applications the work would be done.

STRIPED SQUASH BEETLE.

Fig. 31.

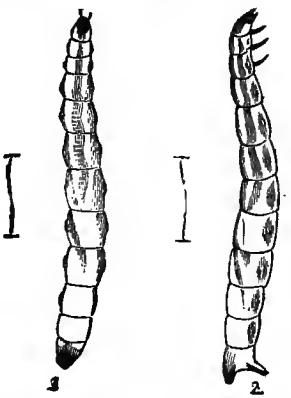


Fig. 32.

Diabrothica vittata. FABR. 1. Back view of the grub that eats the root and stalk. 2. Side view: both magnified. The marks show the actual length. Beetle natural size.

This beetle appears on cucumber and squash vines as soon as they are through the ground, and frequently they penetrate through the cracks made in the ground by the swelling and sprouting of the seeds of melons, cucumbers or squashes, and, biting off the young sprout, destroy the plant before it is out of the ground. These beetles need little description. The cut shows the beetle in outline, and he is well known by the yellowish stripes upon his wing covers. Their subsequent work, also, when the leaves appear above the ground, is well understood, but the biting off the young sprout, thus preventing the development of leaves, is frequently not known, and the seeds are thought to be poor, or other causes are assigned for their non-appearance above ground.

The gardener watches his plants until he thinks them beyond danger from this beetle, and then is surprised to see them wilt and die without apparent cause. No wound or injury is found above ground, and so the destruction is looked for in the root. Here we soon discover the true cause of death, for the roots are found to be pierced here and there with small holes. In fact so many are found that the root presents a corroded appearance. Upon closer examination the authors of the mischief are easily detected, either in the root or lurking in the corroded furrows. They are little whitish worms, about the length of the lines beside the enlarged view of the worms in this figure.

They are, as found, about the thickness of a good sized pin. The head is blackish, brown and horny, and there is a plate of the same color on the last segment of the worm. These are the young of the beetle or "striped bug," which was so troublesome on the leaves earlier in the season, and the eggs from which they hatched were laid low down on the stalk at that time. In this masked stage of worm life they do more damage than when in the beetle form on the leaves. When the worms are full grown, which is about a month from the time they hatch, they forsake the root, and retiring to the earth by continually turning around, they form for themselves a little cavity or minute cave with solid earthy walls, in which they throw off their skin and become a pupa. This pupa is much shorter and thicker than the worm; they remain inactive for about two weeks, taking no food. At the end of this time they throw off their skin again and the perfect beetle is seen, still however in a soft condition, incapable of movement. Remaining in its cell till these soft parts have acquired solidity and strength, it breaks through the walls of its little house, and working itself slowly through the soil appears in the light of day a perfect beetle. We have two generations each year, the second remaining in its dormant or pupa state through the winter. This generation, doing little damage, is not often noticed. Many vines not killed by the worm are so much injured that their value is nearly destroyed.

Covering the vines with a box covered on top with muslin has been considered the only sure remedy, though powdered charcoal, lime, and sometimes ashes can be used wth benefit. In many cases, however, the material sprinkled on the leaf is as bad as the beetle. If a handful of shavings be burned near the hills in the evening, many of them will fly into the flames. After various experiments I have become satisfied that covering the hills with common newspapers is much the best means to be used; besides, you get an accelerated growth of the plants. Just as soon as the seeds are planted, or at any event a day or two before the plants appear, open a newspaper to its full size and spread it over the hill, letting it lie close on the ground, and fasten it in place by hoeing the dirt on the edges, so that no gust of wind can disturb it. The plants thus covered will grow at least a third faster than those not covered, are safe from the beetle, and what is more, safe from the egg that produces the worm or masked stage of the pest. The plants kept covered until the danger is past are more healthy in every way, producing blossoms several days sooner than those not covered. It is seldom that once covering will not answer all purposes, but should one be torn off from any cause it can easily be replaced. I have tried different colors of paper, and find white or blue paper best adapted to the purpose. Other colors seem to give a pale green or sickly appearance to the plants. Newspapers are easily obtained, and are just as good as clear white paper. It will be seen, also, that this is a protection against late frosts, and I believe that every person who tries this method of protection will ever use it with entire satisfaction.

Insect powder, before mentioned, will also kill them, and Paris green or London purple, if combined with flour, can sometimes be

used by dusting the hills with a blower that sends it both sides of the leaves.

TENT-CATERPILLAR OF APPLE TREES.

Clisiocampa Amevicana (Harris).

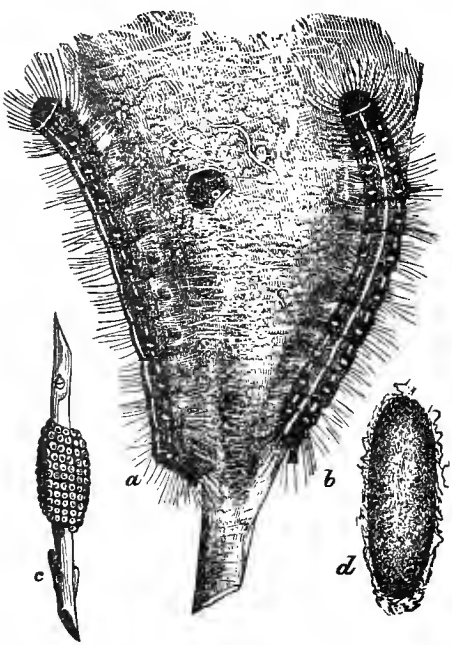


Fig. 33.

All natural size; *a*, larva full grown, side view; *b*, larva full grown, back view; *c*, cluster of eggs on a twig; *d*, cocoon.

Fig. 34.

What farmer in Vermont is not familiar with the web nests of this caterpillar, glistening in the rays of the spring sun, before the trees are in blossom? Yes, before the leaves are one-half grown, these little white web nests speak volumes. They tell of a negligent, slovenly farmer, whose spare hours are got rid of as useless time, and the pests of his orchard revel in his neglected trees, among which the caterpillar holds conspicuous place. This small, white glistening web, if unmolested, soon spreads over several branches, and the caterpillar strips the tree of its leaves, to the great damage of it, if not entailing death, which is ever liable to occur from this cause alone.

This caterpillar is well known to all, yet all do not understand its habits. The eggs are laid by a night flying moth, Fig. 34. Its color is a dull, yellowish brown, or something inclined to the reddish tint; it is unsually thick-bodied and hairy. Its wings are character-

ized chiefly by the front wings being divided into three parts, by two transverse whitish or pale yellowish lines, and by the middle space being paler than the rest of the wing, in the male, while it is often the same color as the rest or even darker, in the female.

Riley says the color is very variable in the Western States. Dr. Fitch notices great variations, but in this section I do not find the variations very great, and think all will readily recognize the moth from the foregoing description.

The moth here described lays her eggs in the night, when she may be found hovering about the tree, in August, or, in the southern part of the State. doubtless in the last part of July. She lays her eggs in oval rings round the smaller twigs, as seen in Fig. 33, *c*. These rings contain some three hundred eggs each, and are covered over with a mucilaginous coating which answers the double purpose of keeping out the water and serving as food for the young when they hatch, to give them sufficient strength to crawl down the limb to the first fork, where, by crawling back and forth, they weave from a spinneret in their mouths the tent in which they live. From this tent they sally forth twice a day for food, eating voraciously. On an average, each caterpillar will eat two apple leaves a day, and no tree can long live under such a vital drain. As the weather gets warm, when the return from a meal, instead of going into their tent, they go to rest upon the outside, as *a* and *b*. Those coming in later and finding room, will crawl over the sleepers, spinning all the time, until they are covered, and another story is added to their tent.

Thus from time to time it is increased with their growth, until their food gives out, or their caterpillar life is spent, when they lose their social habits, and wander off to find other food, which they are seldom able to do, or find suitable places in which to spin their cocoons. These are light colored, with a tinge of yellow, and may generally be found attached horizontally to the under side of fence-rails, or other protected places. They remain in these about three weeks, when such as have not fallen a prey to the ichneumon fly, as many do, come forth to lay their eggs, as before described.

The question so often asked is, how to destroy them? I will first tell you how you ought not. Some flash gunpowder on their nests; others burn them with a torch; while some put on kerosene and burn; and others saturate with oil to kill them. All these methods are destructive to the trees, and should never be employed. Upon a moment's reflection it will be seen that the easiest and quickest way is to cut off the twig containing the eggs.

As they are laid in July or August, there is a long period in which the farmer may destroy them; and as they can be found upon small twigs, near the end of a branch, they can be found with a little careful looking, and cut off. After the leaves have fallen, on a frosty morning the eggs may be readily seen as a dark band on the twigs, as the frost does not so readily adhere to them. When you cut them off alway burn them. If this method is neglected, watch your trees when they first hatch, and with a stick remove the entire nest early in the morning, or just at night,—as they feed, and are conse-

quently scattered over the branches, both in the middle of the afternoon and the middle of the forenoon, and some stragglers are absent all day. If they are still neglected, as they should not be, there is no sure way to rid your trees of them but to put on your gloves and clean them off with your hands. You can kill by crushing, or have an attendant with a pail of hot water, and put in such branches as you cut away, or do not crush. Every tent found, whether on orchard or forest tree, should be destroyed.

The black cherry (*Cerasus serotina*), so common throughout the State, is a favorite tree with this caterpillar. If I could have my way in the matter, as they are a useless tree, I would cut them all down, or else pass a law fining the owner of premises where the caterpillars' nests were not destroyed. Concerted action would soon put an end to its ravages; and the thousands of bushels of apples annually destroyed, together with damage to trees for the ensuing crop, would well repay the amount of time and labor necessary for their extermination.

Where apple trees are overrun, it will feed upon the plum, thorn, rose, willow, common red cherry, poplar and white oak, and even sometimes upon witch-hazel and beech trees. But it will ever be found in the greatest numbers upon the black cherry and apple trees.

FOREST TENT-CATERPILLAR.

Clisiocampa Sylvatica (Harris).

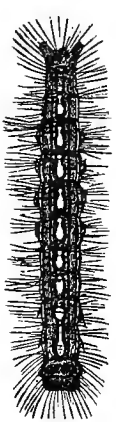


Fig. 35.

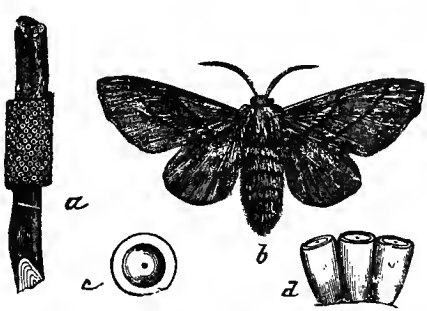


Fig. 36.

a, eggs; *b*, female moth, natural size; *c*, enlarged view of egg from top; *d*, enlarged view of eggs from side.

This caterpillar, Fig. 35, the representation of which is a back view, is often erroneously called the "army worm," and may sometimes be seen in vast numbers, marching along a hard road in the

hot sun, or crawling in great numbers along the railroad track. When closely examined it will be found to resemble the apple tree tent caterpillar, and is often confounded with that, also. The following difference, however, will be apparent:

The eggs, as may be seen from the above cut (Fig. 36), are distinguished from the common tent caterpillar by being of uniform diameter in the entire mass, which is docked off squarely at the ends. They are usually composed of about four hundred eggs, the mass being of a creamy white color. These eggs are deposited in circles around the twig, and with each egg is deposited a brown varnish; the second circle is closely fitted into the first, so the eggs stand like rows of cells in honey-comb. In this section the eggs are deposited in July, or the first of August, the larvæ are quite fully formed by the time winter commences, and the warm days of spring bring them into being, even before there are any leaves on the trees; and it is a singular fact in their nature, that they may not only be frozen, but they actually exist for two or three weeks without food, standing any amount of inclement weather, waiting for the leaf-buds to develop into leaves, which they then eat with hearty relish. As soon as they are born they commence spinning a thread wherever they go, yet as the web is beneath them, close to the bark of the tree, it is often overlooked. They live more or less in company, like the common tent caterpillar, but go through four successive molts before they arrive at maturity, and at such times huddle in bunches, remaining for a day or two inactive. At their fourth molt, they quite unwittingly court destruction by collecting in masses upon the trunks of trees, often within a few feet of the ground. After this molt, it may be seen (as before mentioned) wandering about to find a suitable place to form its cocoon. Why it wanders in such places, and then takes up with a leaf that it can draw together, or several leaves all combined to cover it, we can hardly tell. It, however, frequently spins its cocoons under fence-rails, boards, or any sheltered protection.

The cocoon is much like that of the common tent caterpillar. Three days after its completion, the caterpillar again casts its skin, and becomes a chrysalis, of a pale reddish brown color, dusted all over with a pale powder and densely clothed with short and yellowish hairs. In a couple of weeks more, or usually in this state from the first to the tenth of July, the moth issues, being of a brownish yellow, and having two oblique transverse lines across the front wings. It is quite like the moth of the common tent caterpillar. The most marked difference is, that the transverse bands upon the front wings are darker in this, and lighter in the other species. (b, Fig. 36.)

There is one noticeable fact about this pest; that is, that for several years we see few, if any, of them, and then there is a year or two of great plenty. The reason of this is, that our insect friends, and we fortunately have many that live upon this caterpillar, gain ground upon it, and come near exterminating it; but, with a dearth of food, they die out also, and the caterpillar then gains again, to become a prey to his persecutors.

By their aid we get along nicely, only now and then a year, when we have to kill them to save our trees. If you jar the tree or branch upon which they are feeding, they will spin down a few inches, and may then be picked off. At their fourth molt, they may be killed as they congregate upon the leeward side of trees, as before noticed; but, as they have already eaten up the foliage, it is not so necessary to kill them as it was earlier, yet always kill them when you can. If you search your trees for eggs in the winter, and destroy them, you will never have much trouble.

When one tree is denuded of foliage the caterpillar travels to another and ascends it. This can be prevented by putting tar or printers' ink upon a band about the trees not infested. The cocoons may also be sought for and many killed.

WEB-WORM. *Hyphantria Textor* (Harris).

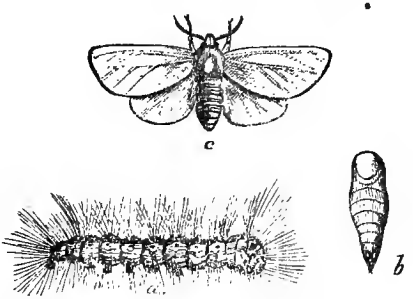


Fig. 37.

All natural size. *a*, caterpillar; *b*, chrysalis: *c*, moth.

One of the most common and destructive of our insect pests is the little caterpillar known by the name of the "fall web-worm," or perhaps more commonly as the "web-worm." The web of this, which at first look seems an insignificant caterpillar, frequently, in the months of July and August, covers the limbs of many trees—a web enclosing leaves seared and dead, from the ravages of this pest. They are more often seen upon elm and apple trees, but other trees are not exempt; and often, towards the end of summer, most of our fruit and shade trees show the ominous web enclosing dried leaves. The eggs from which these caterpillars proceed, are laid by the parent moth in a cluster upon the end leaf of a brance. When these eggs hatch they are generally on the third or fourth leaf from the end of the twig, as since the eggs were laid the limbs have usually extended their growth to that extent.

As soon as they hatch they begin to spin. To provide a shelter for themselves, they cover the top of the leaf with a close web, which is the result of their united labors. They feed in company beneath this covering, devouring only the upper skin and pulpy portions of the leaf, leaving the veins and lower side untouched. The leaf with-

ers, and they enlarge their web, taking in other leaves, first to the end and then downward on the branch, and taking in other branches,—frequently destroying the entire amount of foliage on the tree.

When fully grown, this caterpillar measures a little more than one inch in length, having a body rather more slender than other similar feeders, very sparsely covered with hairs of a grayish color, intermingled with a few that are black. The general color of the body is greenish yellow, dotted with black. There is a brown blackish stripe along the top of the back, and a bright yellow stripe on each side. The warts from which the hairs proceed are black on the back and rusty yellow on the sides. The head and feet are black. Of course their age has much to do with the distinctness of the markings, and the adult worm only will be found perfectly marked.

In the last of August, or more generally in the month of September, they leave the tree and disperse, wandering about, eating a little of almost all plants they happen to find in their way, until they find a suitable place for concealment, where they make their, almost transparent cocoons, composed of a slight web of silk intermingled with the cast-off hairs from their bodies. If this place is not found they bury themselves just beneath the surface of the ground, where they spin as before, and remain in all cases through the winter in this latitude; but farther south they are said to be two-brooded.

The pupæ are transformed to moths in the ensuing June or July. These moths are white and without spots in Vermont, but at the south are said to possess rudimentary spots upon the first pair of wings. The fore legs are tawny yellow, and their feet blackish. Their wings expand about one and one-fourth inches. The antennæ and feelers do not differ from those of other moths; but the females have two rows of minute teeth beneath the antennæ, which is a distinguishing feature (See Fig. 37.)

From the foregoing description of its habits and transformations, it is evident that the time to exterminate these destructive insects is when they are first hatched from the egg, or while but few leaves are involved. This can be done at any time of the day, as they do not go about the tree for food, like the tent caterpillars, but are always on the leaves covered with the web. If you carefully pick the leaves, it is sufficient; or you can cut off the branch affected if you choose. In any event they must be destroyed, and the surest and best method is to burn them. Take a basket into your orchard, gather in it all the leaves on which the web is found, take them to your stove and burn them. Close attention to your premises for a few years will almost entirely rid you of this pest. On no account delay, as, if you do, they will slip through your fingers and very much increase your labors the next season. If they are neglected until they cover more than you desire to prune away, kill as you do the tent caterpillar.

Some consider this the second brood of the tent caterpillar, but from the foregoing account it will at once be seen how widely they differ. It hibernates in the pupa state, they in the egg state; it appears in midsummer and fall, they in the spring; its moth is pure white, theirs reddish brown; its eggs are deposited on the leaf and

are hatched in a few days, theirs are deposited on the twig, so as to pass the winter on the tree; this feeds solely upon the soft part of the leaf under its web, they devour the whole leaf always on the outside of their tent. It will thus be seen that the only time and best manner of extermination must be as above given.

ROUND HEADED APPLE TREE BORER.

Saperda Bivittata. SAY.

Fig. 38.

Figures all natural size. *a*, larva full grown; *b*, pupa; *c*, perfect beetle.

This is a native American, born and bred in the mountains, feeding upon the wild crab, mountain ash, and various other trees. It comes out of the trunk usually in June and always by night, in its perfect state. Resting by day, in the night time it flies from tree to tree for food and companions. Though they feed upon the bark of branches where it is tender and succulent, they lay their eggs on the bark at the foot of the tree, where the young, as soon as hatched, commence to burrow in the bark. For the first year they live mostly in the bark, but towards the last of the season advance into the sap wood. Frequently, in young trees the bark over them will crack and allow their castings to fall out, and thus they may be detected. They remain in the trees three years. As the time comes for their exit, they eat their way to the bark, thin that somewhat, and go into the pupa state to emerge perfected in about four weeks. Fifty years ago large, thrifty, long lived apple trees were exceedingly common, and were grown with comparatively little effort on the part of our ancestors. This borer in the apple tree was then entirely unknown to the farmer, and the first specimen ever seen was found and described by Thomas Say in 1824; and it was not till some time after that its destructive powers became evident in the apple tree. Yet it is to this borer, almost entirely, that the short and precarious life of the apple tree is due.

All understand this borer to be a dreadful pest, but how to deal with it is the question; and to show more fully its habits and how it may be exterminated, I will briefly review its history. The eggs

when laid, as before mentioned, soon hatch, and the tiny worm, differing from the adult in no essential point but size, eats into the bark, and then follows between the bark and wood, sometimes entering the sap wood low down towards the root the first season. While eating its way in lengthy furrows beneath the bark, the bark sometimes cracks and the castings of the worm tumble out, revealing its presence. When such is the case they may be killed with a sharp wire, or carefully cut out with the point of a knife. If left alone they will remain inactive through the winter, to commence their work again early in the spring. The second season they spend mostly in the sap wood or near the bark, getting two-thirds their size, and this year doing their greatest damage, as five or six of them will frequently girdle or nearly girdle the tree, making death sure; they again winter low down in the body of the tree, and eat the next season deeply into the wood, sometimes quite through the tree, finishing its gnawing work at the commencement of the third winter. At the close of its work it extends its passage invariably to the bark and thinning that somewhat, stuffing the upper end with wood, like sawdust, and below with soft wood fibres, it rests from its labors, remaining motionless as before through the winter. The following spring it casts off its skin, becoming a pupa; rests in this condition about three weeks; and then as a beetle, gradually gets strength, and after nearly two weeks more cuts its way through the sawdust piled against the bark, and then the bark, to issue through a round hole as an adult beetle, ready to propagate as before. The time from its entry to its egress is about one month short of three years.

Few ever take the trouble to hunt for this beetle, and as it flies in the night, lying concealed during the day, it is not often seen in the adult state. As will be seen in the cut it has two stripes its entire length, and is rather handsome. (Fig. 38).

There is still another species, called the flat-headed species, as the head of the larva is flat, but as it is never very abundant and is of small size, it seldom does much harm, and the same treatment is destructive to both species.

The best remedy is to prevent the successful laying of eggs, which may be done by smoothing and then soaping the bark. If such is done near the ground only, they will lay their eggs at the juncture of the largest limbs or higher up on the trunk, so scraping and soaping must be thorough. If the borers are really in the trees there is no way except to kill them, or cut them out one at a time. A small piece of whalebone is the best to kill them with, by pushing it into their holes. A piece of wire will answer. When the bark is killed over them it is just as well to cut them out. The application of the soap is necessary in May. Either soft or hard soap will do, but if hard soap is used a thin piece had better be crowded down into each principal crotch of the tree, so that the rain may wash it down the trunk. Do this, of course, after having washed the tree with strong suds.

CODDLING-MOTH. *Carpocapsa Pomonella* (Linn.).

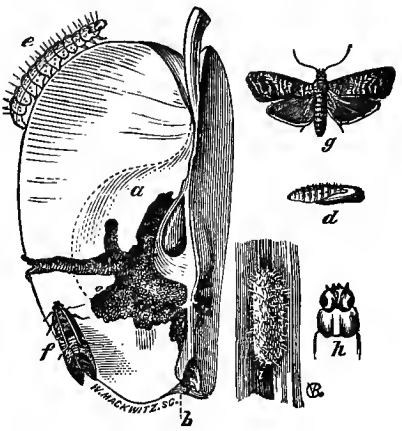


Fig. 39.

* *a*, apple eaten by larva; *b*, spot where egg is laid and the young worm enters; *c*, cavity made by larva; *d*, chrysalis; *e*, larva full grown; *f*, moth with wings folded; *g*, moth with wings expanded; *h*, head and first joint of larva (enlarged); *i*, cocoon.

This insect is, doubtless, found everywhere, where apples are raised. In the month of June, in this State, the night flying moth comes from his silken cocoon, which was hid under some bit of bark, or sliver, on the fence near by. After pairing, the female may be seen in the dusk of night flitting around the apple tree, laying her eggs in the blossom-end of the little apples.

This is a most exquisitely colored insect, but a magnifying glass and a good light are required in order to bring out all its beauties. The upper wings are rich brown, banded at the base and tip with a darker and warmer brown. In the dark band at the tip of the wing is an oval mark of brilliant gold colored scales, having a very dark center. In certain lights this dark center takes a reddish hue, while a golden gloss pervades the whole of the wing. Even the outer wings when viewed in a side light, shine as if made of the richest satin. By a proper adjustment of the light, a rather curious effect can be produced. The wings of one side glittering and shining in full splendor, while the corresponding wings of the other side are nothing but dull grey, brown and black. So excellent a description of the ravages of this little moth is given by Mr. E. Newman that I will let him speak for himself:

"It is the most beautiful of the beautiful tribe to which it belongs; yet from its habits not being known, it is seldom seen in the moth state, and the apple grower knows no more than the man in the moon to what cause he is indebted for his basketful of worm eaten windfalls in the stillest weather.

"To find the moth in the daytime, the trunks of the apple trees should be carefully looked over; or if your orchard be surrounded

by wooden fence, the moth may often be found sitting against it, with its pretty wings neatly folded round its body. Towards evening—in fact, at sunset—it begins to move, and may then be seen hovering about the little apples which, by the time the moth leaves the chrysalis—the middle of June—are well knit, and consequently fit for the reception of the eggs, which it lays in the eyes, one only in each, by introducing its long ovipositos between the leaves of the calyx, which forms a tent about it, that effectually shields it from the inclemency of the weather, or any other casualty.

"As soon as the egg hatches, the little grub gnaws a hole in the crown of the apple, and soon buries itself in its substance; and it is worthy of remark that the rind of the apple, as if to afford every facility to the destroyer, is thinner here than in any other part, and consequently more easily pierced. The apple most commonly attacked is the early sort, which ripens in August and September.

"The grub, controlled by an unvarying instinct, eats in the apple obliquely downwards, and, by thus avoiding the core and seeds, in no way hinders its growth. At first it makes but slow progress, being but little bigger than a thread, but after a fortnight its size and operations have increased; it has now eaten half way down the apple, and the position of the hole at the top, if the apple continue upright, or nearly so, is inconvenient for a purpose it has up to this time been used for, that is, as a pass to get rid of its little pellets of excrement, which are something like fine saw dust or coarse sand. Another communication with the outer air is therefore required, and it must be so constructed as to allow the power of gravity to assist in keeping it clear; it is accordingly made directly downwards toward that part of the apple which is lowest, and thus the trouble of thrusting the pellets upward through the eye of the apple is saved, and a constant admission given to a supply of air without any labor.

"The hole now made is not, however, sufficiently open for an observer to gain by its means any knowledge of what is going on within; this is only to be obtained by cutting open a number of the apples as they gradually advance towards ripeness; the hole is, however, very easily seen, from its always having adhering to it on the outside an accumulation of little grains which have been thrust through.

"Having completed this work the grub returns towards the center of the apple, where he feeds at his ease. When within a few days of being full-fed he, for the first time, enters the core through a round hole gnawed in the hard, horny substance which always separates the seeds from the pulp of the fruit, and the destroyer now finds himself in that spacious chamber which apples have in their center. From this time he eats only the seeds, never again tasting the more common pulp which hitherto has satisfied his unsophisticated palate; now nothing less than the high flavored, aromatic kernels will suit his tooth, and on these for a few days he feasts in luxury. Somehow or other the seeds of an apple are connected with its growth as the heart of animal with its life; injure the heart, an animal dies; injure the seeds, an apple falls. Whether the falling of his house gives the

tenant warning to quit, I cannot say, but quit he does, and that almost immediately; he leaves the core, crawls along his breathing and clearing out gallery, the mouth of which, before nearly closed, he now gnaws into a smooth, round hole, which will permit him free passage without hurting his fat, soft, round body; then out he comes, and for the first time in his life finds himself in the open air. He now wanders about on the ground till he finds the stem of a tree; up this he climbs, and hides himself in some nice little crack in the bark.

"I should remark that the fall of the apple, the exit of the grub, and his wandering to this place of security, usuall take place in the night time. In this situation he remains without stirring for a day or two, as if to rest himself after the uncommon fatigue of a two yards' march; he then gnaws away the bark a little, in order to get further in out of the way of observation; and having made a smooth chamber big enough for his wants he spins a beautiful little milk-white silken case, in which, after a few weeks, he becomes a chrysalis, and in this state remains throughout the winter and until the following June, unless some bird peeping into every cranny happen to spy him, in which case he is plucked without ceremony from his retreat, and his last moments are spent in the bird's crop; but, supposing no ill-fortune betide him, by the middle of June he is again on the wing and hovering round the young apples on a midsummer evening as before.

"By burning weeds in your garden at this time of year, you will effectually drive away this little moth. If you have trees the crops of which you value, make a smoking (mind! not a blazing) fire under each; it will put you to some inconvenience if your garden be near your house, but the apples will repay you for that."

Despite these destructive habits of this insect—perhaps in consequence of them—I have always cherished a kindly reminiscence of this moth. When I was a child there was a remarkably fine tree in the garden, the fruit of which ripened early and was particularly juicy. As children we were not allowed to gather the fruit at our discretion, but were permitted to take that which fell, without any unfair means being used, such as beating or shaking the branches. Thanks to the codlin moth, a considerable number of apples always did fall annually, having ripened much before their time, as is the manner of fruit which will never come to perfection.

Like most larvæ which never see the light until they are full fed, the caterpillar of this insect is nearly colorless with the exception of the head, which is brown black, hard and shining. Hogs in the orchard in such numbers as to eat all the fallen fruit is a sure relief from the depredations of this pest. Knocking off the wormy fruit with poles is also a good practice, then pick up and boil it. If this is not done, cloths laid in the crotches of the branches to shelter the worms and entice them to build their cocoons, wisps of hay or straw wound round the trees, folded or twisted paper bands put around the trees, or any attachment that will afford shelter to the worm and entice it to spin its cocoon, in such a way that it can be destroyed, is beneficial. These bands or cloths, after the cocoons are formed, should

be burned so as to make the destruction sure. They should first be placed about the trees about one month after the tree is in full blossom, and from this time to the time the apples are picked they should be kept in order, being examined every week, and if cocoons are found they should be at once destroyed and new bands put in their places, or if but a few they may be crushed and the old protectors remain.

In a letter received this season I am asked the philosophy of the hay or straw bands. I can only say, with Prof. Riley, that the straw or hay bands simply afford an enticing shelter for the worm when seeking for a place to build its spun up house. The hay band is just the thing wanted, as it affords the requisite shelter, and in ninety-nine cases in a hundred will be accepted. There are many patent traps for the same thing, but I am at least safe in saying that none of them are any better than the straw band; many not half as good.

Of the second crop of wormy apples, which are found so often in the barrels that find their way to market, I can only say that a careful examination in early spring of the barrels and the cellar in which they are kept, and the careful killing of all the cocoons that are found, will do much towards preventing the early brood. Though they have a few natural enemies, they are not in such abundance as to allow the orchardist to depend upon them in the least, and so I need make no mention of them.

COMMON HOUSE-FLY. *Musca Domestica* (Linn.).

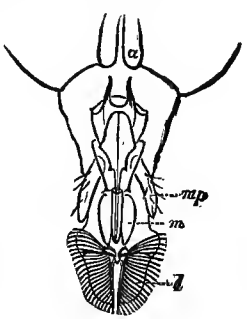


Fig. 40; Tongue.

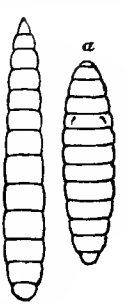


Fig. 41; Larva and Pupa.

This is the most persistent companion of man. It has followed him everywhere, and is to be found where he is found.

With the warmth of spring the fly begins to show his familiar form in our dwellings, and to inspire the careful housekeeper with dread, but where it comes from, or how it has passed the winter, is usually unknown.

Not all who have watched the fly make his toilet, or even looked at him through a magnifying glass to see the little parasites upon him, realize that once he was a disgusting maggot as unlike his per-

fect self as well can be. The eggs of the house fly are about four-hundredths of an inch long and half as wide, white, pitted, and with hexagonal depressions. They are mere white specks piled by the parent on warm manure or decomposing vegetation—each female laying several hundred. The excrements of the horse are the most desirable, and yet they may, for want of that material, deposit them on other refuse of the barn, and sometimes even on sand or loam that is made rich by the wash of the buildings. The eggs hatch almost immediately, producing a maggot, fleshy, smooth and shining, about one-third of an inch long, and yellowish white (Fig. 41.) After feeding for some time it goes into the pupa state, shortening up as in *a* (Fig. 41.) It is a reddish brown case, two-thirds the length of the maggot, and, as seen in the cut, thicker and stouter. In this transition case, it remains from six to ten days—according to the warmth of the weather—emerging therefrom a perfect, full-grown fly. I have frequently called the attention of the farmer to the pupa case asking him what it was. He almost invariably answers that he supposes them undigested oats that have passed his horse; and in several instances they were dosing horse for indigestion, having taken these pupæ for the signs of such. From inquiry thus, I have concluded that most farmers notice the pupa cases, but do not understand what they are. I have never known the house fly to lay its eggs upon meat, or anything about the house, though they sometimes do about a sink-spout, or other places where slops are thrown out. With a little concerted action among our population, the house fly might be greatly decimated in numbers. All barnyard fowls are fond of the larva and the pupa also, and, if yarded where they have full access to their breeding grounds, will greatly aid in their destruction.

There is in the study of the proboscis and tongue-like organ, as seen in the cut above (Fig. 40), much for study. The maxillæ are minute, and their palpi (*mp*) are single-jointed, and the mandibles (*m*) are comparatively uselesss, being very short and small compared with the lancet-like jaws of the mosquito. But the structure of the tongue itself (*labium, l*) is most curious. When the fly settles upon a lump of sugar, or any other eatable sustance, it unbends its tongue, extends it, and the broad, knob like end divides into two broad, flat, muscular leaves (*l*) which thus present a sucker-like surface, with which the fly laps up his food. These two leaves are supported upon a frame-work of tracheal tubes, which act a set of springs to open and shut the muscular leaves. These, it will be seen from the magnified cut, end in hairs projecting externally. Thus the inside of this broad, fleshy expansion is rough, like a rasp, and so is easily employed by the insect in scraping or tearing delicate surfaces. It is by means of this curious structure that the house fly occasions much injury to to the covers of books, or any polished surface that owes its polish to albuminous material. It is by means of these, also, that it teases us in the heat of summer, when it alights upon the hands or face, to sip the perspiration as it exudes from, and is condensed upon, the skin.

Doubtless all have noticed that house flies are more numerous

about barns, but few trace the transformation. The barn and its vicinity are usually its birth-place, and about such places may be seen in June, now and then, stray flies, the remnant of last year's brood, that have in some sheltered nook survived in a dormant state the cold of winter.

If such outhouses were neat and clean as they should be, the number of flies could be greatly decimated. Is it not worth our while to do the best we can to exterminate them?

FORESTRY.

By Dr. H. A. Cutting.

Vermont is not old in history. Almost within the memory of her oldest inhabitant the State was a forest of valuable timber. Her pine lands were among the most beautiful on the continent. Her crystal streams were cold and very regular in their discharge of water, forming fine mill sites, and her springs were trusty reservoirs for household or pasture. But there has come a change. We are no longer proud of her stately pines, and many mill streams have no longer the wherewith to turn a mill, and springs once never failing are some of them numbered with childhood scenes that have long ago departed. Let us glance at our timber supply in Vermont at present. From the forests in Franklin county the pine has been mainly culled out, but hemlock still abounds. The lumber is worth $8 to $10 per thousand, and bark perhaps $7 per cord. Basswood and ash bring $10 to $20. The spruce is now being rapidly manufactured into butter tubs, most of which are shipped west. On nearly all the farms are orchards of the sugar maple, ranging from 100 to 1,000 trees. Those orchards are not only held at higher value than other timber land, but in many cases bring more per acre than cultivated lands of the same quality. The forests, as near as I can ascertain, yield 25 to 50 cords of wood per acre, worth from three to four dollars per cord. It is thought by the farmers and with reason, that the railroads with their great demand for wood will soon use up the same, so as to make a scarcity and consequent increase in price, unless measures be taken to reproduce a new growth. The forests in Chittenden county are already nearly all second growth. There are, however, some extensive tracts of cedar; also hemlock large enough to peel bark, which is in good demand. In Essex much of the original forest is left, but at the present rate of consumption 20 years will denude it of all first growth timber, and some think it will be done in much less time. Some tracts of timber now yield 75 thousand to the acre, while the average of first growth will doubtless fall below 20 thousand. So with wood which ranges from 10 to 200 cords per acre. In Orleans county there is still much original growth, but it is fast disappearing. The hills are largely covered with hard wood, which in many places is almost wholly sugar maple, the trees being from one to two and a half feet in diameter. Land having from 50 to 100 trees per acre is worth as much as tillage land. The spruce is in great demand and is rapidly disappearing. In Lamoille one-half of the forest land is soft timber, which is rapidly being cut off. Some maple orchards sell from one to two hundred dollars per acre. The quality of sugar is excellent, selling

from 10 to 15 cents per pound. Railroads and manufacturing establishments are fast stripping Caledonia county of all timber except in inaccessible places. Good wood or timber land sells for $100 per acre. The pine once so abundant is nearly all gone. That you may the better compare in your mind's eye the different parts of the State, I will give you the timber percentage of each county. I wish, however, to have you bear in mind that as I take this from the census report it includes highways, water and ledges, swamps, etc., not cultivated. Addison, 27 per cent; Bennington, 32; Caledonia, 34; Chittenden, 22; Essex, 49; Franklin, 28; Grand Isle, 18; Lamoille, 43; Orange, 26; Orleans, 44; Rutland, 27; Washington, 32; Windham, 28; Windsor, 24, which gives an average for the State of 30 per cent, which means about 25 per cent of actual forest, including all second growth, which is about the average of the whole United States. But at our present rate of consumption where shall we be in 30 years? Can any of you tell? Your legislature came near passing a law that you should not use barbed wire fence at the last session. As things are going now what will you fence with 30 years hence? It is certainly worth your earnest consideration. I am sorry Vermont did not lead in laws encouraging the planting of trees. California pays a premium of $1 for each tree planted upon her highways, if of reliable kind and in thrifty condition four years after planting, the same to be shown by commissioners appointed for the purpose.

Illinois, Missouri and Iowa encourage tree planting. Massachusetts offered a premium of one thousand dollars for the best plantation of forest trees. This was won by Maj. B. P. Poore. State societies have also in many states encouraged tree planting, but as yet there has been no special advance. The general government has, however, enacted some laws in relation to her public lands looking toward the cultivation of forests, but as yet they have been anything but efficient. Still, under the laws of preservation and cultivation in Europe much has been done, yet in Great Britain the forest area is but 5 per cent of its domain. Her coal fields have thus far supplied her fuel, but please tell me what she will do when they, too, are exhausted? Cut off her importations of lumber to day and make her dependent upon herself, and what could be done even in her cities of brick and stone? Let us think. In the erection of the ordinary stone or brick buildings, with wooden floors and joists, it is estimated that the cost of lumber for sash, doors, roofing, flooring, etc., is an expense equal at least to the cost of brick and stone. The wood work then represents one-half its value, but is that all? If the building is one of brick the expense of the brick was one third in their burning. In like manner one-half the value of the lime was from the wood in burning. It was a wooden wagon that took it to the kiln and brought it from.

The brick maker, the lime burner, the stone mason, the brick layer, the plasterer, the painter, the carpenter, have all needed wood in their dwellings, in their tools, in their work almost from beginning to end it has been wood, incessantly wood. In every avocation of life we can little more dispense with wood than we can with food.

We raise and manufacture large amounts of cotton, but three times as many workmen are employed on wood. We have many mills that produce flour, but we have thirteen times as many producing lumber, and that, too, at a rapid rate. The lumbermen of Vermont employ 4,500 men, and the value of their product is near three and a half millions of dollars annually.

The time is close at hand when economy must commence because of increase in prices. I cannot better illustrate the imminent danger to our land by the destruction of forests than to use the words of that famous French potter, Bernard Pallissy, who died in the bastile for his religion in 1589. Having expressed his indignation in no measured terms at the wanton destruction of timber he says, "I cannot enough detest this thing. I call it not an error, but a curse to France; for when forests shall be cut all arts shall cease, and they who practice them shall be driven out to eat grass with Nebuchadnezzar and the beasts of the field. I have divers times thought to set down in writing the arts that shall perish when there shall be no more wood, but when I had written down a great number I did perceive that there could be no end to my writing, and having diligently considered, I found that there was not any that could be followed without wood." But there are many persons who have an idea that coal will take the place of wood, and so it may to a great extent, but I have yet to learn how those using it can entirely dispense with wood. Again, as the cost of mining coal increases and one mine after another gives out as they surely must, will not coal be an expensive fuel, at least to those removed from coal mines. But hear what the London *Times* says in reference to a calculation, based on the English census reports and the uses of coal: "In three generations, that is in the days of our children's children, we are told that our supply of coal will be exhausted, if its use goes on at the present increase of consumption. Coal is everything to England. Without coal our furnaces will become idle, our factories and workshops will be still as the grave, the locomotive will rust in the shed, and the rail be buried in weeds. Our streets will be dark, our houses uninhabitable, our rivers will forget the paddle wheel, and we shall again be separated from the United States; by months of time. Our arts and manufactories will fly the soil, and wise England will then be like the silly virgin without oil in her lamp."

Should not such words as these arouse Vermonters to the value of wood, which has a value here now of at least four times its value for fuel. Our general government has no control over the wood lands of Vermont, hence is it not the duty of every citizen to aid in preventing waste? It is the duty of our State to aid in the development of knowledge and science, necessary to aid the husbandman to do the best he can in the production of timber, because individual experiments are not remunerative, and a unity of action is necessary for great results. The general diffusion of knowledge is also the duty of a State, but it is never done unless there is a demand for it, and the demand must come from the people.

A vast mistake exists in the minds of many men as to the relative values of different woods. As to their ability to produce heat, cer-

tain kinds of wood are preferred by the purchaser, because his father used it, or because some friend told him it was best, and he will have it at any price, and will buy only what he desires and his neighbors do likewise, and so a whole village will settle down on beech, birch or maple, and the producer cannot in consequence sell his other wood and he burns it up in heaps. A wanton destruction. I therefore introduce from the carefully prepared tables of Marcus Bull, upon the value and heat of American woods, the value of our more common kinds, placing hickory as the best at 100. Of forty-six different kinds in common use here only five stood under 50, that is only five that were not half as good.

These were Lombardy poplar, 40; Aspen poplar, 42; white pine, 43; basswood and white birch, 48. Rock maple or sugar maple is only 60. Eighteen varieties are better than this maple, among which were all the small-growing trees, like alder, yellow birch, whistlewood, mountain ash, cherry, etc., which are almost always destroyed in heaps rather than burned as fuel. Red oak and red heart hickory were 81; white oak and chestnut, 86, and pig nut hickory, 95.

In relation to our wood lots let us remove trees carefully, and for the growth and protection of the remaining forest, taking such as are likely to blow down or so near dead as to be slow growers. By all means exclude domestic animals from the woods; the damage they do is irreparable. Encourage our farmers to study the value and rapidity of growth, so they can properly cherish the reproduction of timber; let them thin out the poorest trees where they stand too thickly. Take away large branching, indifferent trees where woods are sparse, and set young trees, or plant nuts of valuable varieties, in the area thus opened. This lets the sunshine in to start them and they will grow rapidly. If you plant nuts and seeds of trees in shady places, the seeds may not sprout for a thousand years or never.

Our woods in Essex county, and I presume other sections of the State, are filled with the seeds of the common wild cherry, and yet not one starts until the old growth is cut away, when they come up in countless numbers. If the four million farmers in this country would each give an hour of real thought to this subject, and then practice their own convictions, the result would profit this nation hundreds of millions of dollars.

Our farmers should consider the ultimate pecuniary benefit of such a course, for themselves and their children after them, both in the better incomes of their farms, and their greater value to thier families if, in time, they should be sold. We are cutting down too much of the timber for the benefit of our cultivated fields, we are thus removing the extended and grand instrument which God uses in nature for greatly controlling the extremes of temperature, and moderating the violence of wind and irregular rainfall.

Cutting off timber to raise grain, will, when carried far enough, change those rich fields to very moderate grass lands. The lesson of the goose that laid the golden egg should check our thoughtlessness, and lead us to save our timber and even produce more, thus preventing many diseases that will stab our loved ones as with a

dagger, we could then cultivate with greater care and thoroughness the present fields. *Every word that has or may* be written or *spoken* in this country on this subject will be a blessing. Every man who has experimented to however small an extent, whether led thereto by his own necessities for trees or by love for the enjoyment, has been and is to-day a public benefactor. Like the cloud no bigger than a man's hand just rising from the sea, an awakening interest will come on this subject, which as a question of political economy will place the interests of cotton, wool, coal, iron, meat, and even *grain*, beneath its feet. We can subsist without *any one* or all of these, but without wood *never*.

But let us look at it as a profitable investment. Can we place capital anywhere where it will increase as fast as here? Let us for a moment consider. If we count the rings of growth on the section of a tree we find a series of circles on the general average about equal in width from year to year. These counted from the middle outward form a series 1, 2, 3, 4, 5, etc., corresponding with the years of a tree's growth. The areas of these circles are as the squares of these numbers, or 1, 4, 9, 16, 25, etc., and thus it will be seen that the gain of growth from year to year is the difference of these sums, or 3, 5, 7, 9, 11, 13, etc., an arithmetical series, having a common difference of two. I will again ask what other investment pays such rates as this? Yet the truth is not *yet half* told, for I have said nothing of the increasing height and consequent increased value in that direction.

I need not, I trust, remind you that the importance of this subject has long engaged the attention of *foreign* governments, and that to day in every country of Europe they have some system of forest management. The more elaborate systems are in France and Germany. They have been perfected through centuries of experience. They have their schools of forestry as we have our military schools, under government instruction, and those instructed thus become agents of government, subject to promotion, retirement, and after a life in the service are pensioned. But I will not longer speak of the tree's growth, but of the immense waste as we use our lumber. Scarcely one half of the timber cut becomes available, the waste of sawdust, shavings, pieces, are continual; when we burn it much goes to waste in smoke and gas.

But as the demand, so is invention. A few years ago wood began to be worked into paper pulp; but it was selected wood, and had to be first ground on grindstones, and like all other wood-working machines, it made much waste; but soon came another invention, which can be seen in operation in Gorham, Me., taking refuse wood of all kinds, be it sawdust, shavings or twigs, even, and by the disintegration of fibre it converts it without any waste into pulp, from which may be compressed any instrument made of wood; let the article be barrel, keg, pail, basket, carriage wheel, boat, chair, shovel handle, or any finish about a house, or utensil made, it matters not what its form the cast from the mold is perfect: much harder, and said to be stronger and more compact than the original wood, consequently it will take a higher finish, and as many articles have to be made from

many pieces, while in this way it will be all in one piece, and hence much stronger and entirely free from shrinkage, warping or cracking, and as it has no pores, it will not watersoak. After casting, it can be turned and smoothed in a lathe as well as any wood. Though the invention is a new one, the demand for articles thus made is very extensive, and it is already an extensive industry. May all welcome this invention, and hope that the time is near when all waste of wood may cease.

Permit me further to mention an economy in the manufacture of charcoal, which may be witnessed in an adjoining state. At an iron furnace where large quantities of charcoal are required for smelting ores, a chemical company has established works for saving the volatile products from burning wood into charcoal, and turning them to commercial account. The superintendent says that two months ago his company paid twenty cents for smoke from every cord of wood burned into coal, but since then smoke has *risen*, and the company pay 31¼ cents per cord. This would seem high for a waste product, but the chemist informs us that from the smoke of every cord of wood he gets two gallons of wood alcohol, worth 85 cents per gallon and used for making shellac varnishes, etc.; and further, that the acid residue after the distillation of the alcohol he neutralizes with freshly slacked lime, and evaporated to dryness is worth 2½ cents per pound. From a cord of wood the yield of charcoal averages 42 bushels, which is worth $3.00; the chemical products above, are worth $6.70, making a value of $9.70 per cord for the wood. But this is not all; the combustible gases used for light and fuel supply at least three-fourths the cost of production, and might be turned to more profitable account, but as it is you can see that smoke, the waste product, is in reality worth more than double the charcoal.

I would, if time permitted, tell you the great benefit to be derived from the planting to timber of worn out and abandoned lands; but I will pass that to tell you the great changes to climate and country the general cutting off of the forest produces.

We ought to learn from the experience of other nations great and terrible lessons without madly insisting upon suffering the same disaster ourselves. The history of the world presents to us a fearful record respecting the destruction of forests. Palestine and Syria, Egypt and Italy, France and Spain, have seen some of their most populous regions turned into uninhabitable sections and their most fertile lands into arid, sandy deserts.

The danger to our land is near at hand, nearer by many years than the unthinking suppose. There are parts of Asia Minor, of Northern Africa, of Greece, and even of Alpine Europe, where the operation of causes set in action by man has brought the face of the earth to a desolation almost as great as that of the moon, and that, too, in the brief space of time known as the historic period. They are known from historic record to have been covered with luxuriant woods, verdant pastures and fertile meadows; they are now too far deteriorated to be reclaimable by man. Nor can they be again fitted for any use only by miraculous changes in nature under the hand of God, which is not likely to ever be. The earth in fact from this vandal spirit in

man, is fast becoming an unfit home for its noblest inhabitant, and another era of human depredation and improvidence like that of the past would reduce our fertile land to the verge of starvation and barbarism. But the time referred to here is not necessary for the transformation, for the destructive changes occasioned by the agency of man upon the flanks of the Alps, the Appenines, the Pyrenees, and other mountain ranges in central and southern Europe, and the progress of physical deterioration have become so rapid that in some locations a *single generation* has witnessed the beginning and the end of the melancholy revolution. It is as certain as that night follows day that a desolation like that which has overwhelmed many once beautiful and fertile regions of Europe awaits an important part of the United States, unless prompt measures are taken to check the action of vandalism already in operation. Our free institutions of which we boast, and actual ownership of the soil which we possess, gives little chance for the protection of actual law. The only legal provisions from which anything can be hoped are such as to make it of *private* advantage to the *land owner* to spare the trees upon his ground and promote the growth of wood, by exemption from taxation, or otherwise of improving woodland. But the call must come from the people. On no point of practical results are both writers and observers more thoroughly agreed than in affirming the value of forests as agents of at least local amelioration of climate. They also furnish an essential condition of the growth or improvement of a soil by chemical decomposition of its elements, and by the deposit in or on it of vegetable mold. The soil beneath trees never dries as it does in cleared land. It is in a condition to allow all water, whether from rain or snow, to permeate it. These waters carry more or less ammonia with them, whice is a chief agent of rock decomposition. The soil being deep holds water long, yielding it slowly by evaporation, and by its equally slow drainage establishes permanent springs. The first result of too great and general clearing of forest is to dry up the springs and small streams or render them less permanent; next, to harden the surface soil, forming a stiff mass which sheds the water from ordinary rains, and can only be fertile through tillage. When I was a boy only 35 years ago, in my native town there was a meadow stream a mile long at least, with dark, deep, still water, and ranged in width from 15 to 30 feet. The stream was large enough for a mill stream, and two saw mills were upon it. Its tributaries were in the forest, and two of them were considerable streams. It was excellent fishing. Three years since I looked over the same ground. The tributaries were mostly through mowland, their deep channels had disappeared, the streams were dry, and what astonished me most the meadow stream was nearly dry also, and last season it was quite so. It was to me a remarkable change. I visited also several springs that were formerly large and constant, but they were dry. So it is in Lnuen burgh, also, and the decrease has in some instances been one-half in twenty years. On the other hand by the cultivation and starting of trees and shrubbery about Salt Lake the amount of rainfall increases, and the surface of the lake is many feet higher than on the first set-

tlement of its shores. Humboldt, Herschel, Bonsingault, Marsh, and other scientists understood and wrote of this same diminished rainfall. Yet there is another change. After clearing the rain is less equable and more deluging, as well as less in quantity.

Forty years ago large barges loaded with goods went up and down Cuyahoga river in Ohio, but now a canoe can scarcely pass down the stream. Mill Creek in Illinois once afforded water for mill purposes the year around. Now it affords but little running water at any time, and for many months each year it is dry. The waters of the great western rivers are continually diminishing. Some flatter themselves that they are deepening their channels in places and widening them in others, but this is deception and untrue. The fact is there. In Germany measurements have been made of the waters of the Elbe for the last 80 years. The water now discharged is full 18 per cent less than at the beginning of the period. The reason is that millions of acres of land at its head waters have been denuded of timber. On an elevated plain in South America the chocolate plant found its most congenial climate, and so the whole plain was robbed of its forests to extend the plantation. The result was that the rains almost ceased, and the cultivation of the plant had to be abandoned. The trees were at length restored, and with their growth came the usual rain. St. Helena became almost barren by cutting off its forests. Thirty years ago they were replanted, and during this time the rainfall has more than doubled.

Fifty years ago Mehemet Ali planted fifty millions of trees in Egypt. Previously there had been little rain, frequently none for sixteen or eighteen months; for the last five years they have averaged thirty days each year of rainfall. Mr. Tice attributes this change to the electric influence of the trees. The rain clouds being positive, while the trees are negative, they are attracted thither and loose their water there.

Electricity everywhere mounts the highest points, and the trees being above the surface of the plains seems to offer a reasonable explanation. Sir Gustave Wex says that the change of woods into cultivated land has caused a considerable decrease in Danish rivers. The royal board of canal directors in Norway, show that at two water-gauge stations on the Glommen river, have, during thirty years, shown a gradual decrease. In Italy, Mr. Farelli shows that by accurate measurement the discharge of the rivers is less by 33 per cent than they were one hundred and fifty years ago, and last, but not least, comes the records of China showing remarkable changes from the same cause.

In the northern province of the Chinese empire, Shan Si, whose capital is Tayeum is inclosed on all sides by high mountain ranges which in early ages were covered with dense forests. At that time it rained here every year; the atmosphere was humid, and it belonged to the well cultivated and densely settled provinces of the Chinese Empire. But the inhabitants of this once blooming and happy country, through greed and in the endeavor to increase the yield of these mountain slopes, cut off all the trees. The result is that the rains have become fitful and uncertain, the atmosphere is

dry, and that in consequence, the continued failure of crops has produced poverty and misery almost unheard of. In 1877 there was almost a total failure, and in consequence thereof three millions of souls perished. In the official report of the governor, Li Ho nieu, the following account appears:

During the first period of this unheard of famine the living subsisted upon the corpses of the dead; then later the weak were devoured by the strong; now the misery has reached such a stage that the people devour their own blood relations. History up to this date has not shown a more horrid state of affairs than this, and unless measures for relief are promptly taken the entire population of this section of the country will be destroyed.

The Catholic Bishop in a letter from Tayeun, dated March 24, 1878, corroborates the description contained in the report of the horrible scenes enacted during the famine.

The ruinous results of clearing the forests are also subject of record in various provinces of China, both by devastating floods and drought.

But why multiply instances? The world's history is full of them, and we can choose between sunshine, rain and harvest, most bountiful with protected forests, or fitful rains, long drouths, and ultimate desolation without them.

HYGIENE OF FARM HOMES.

A lecture delivered at several meetings of the farmers by HIRAM A. CUTTING, M. D., Secretary of the Board.

HEALTH.

Who is there so much as the farmer that imperatively demands good health? The labor on the farm is exacting, requiring muscular strength and activity, and it will admit of no postponement or delay. When seed time comes the farmer must put in his seed or he will have no harvest, when mature, his crops must be gathered or he sustains loss, between seed time and harvest comes the hay crop, which must be gathered in a given period or there is loss. Dr. Kedzie says, "The operations on the farm have no season set apart for sickness; they march with every step by nature's side, and like the seasons they brook no delay."

It is true that sickness injures the prosperity of any man, but the laborer, the mechanic, the artisan, while disabled from that cause lose only the days that their labor is not remunerative, but when able, go to work with the simple loss of the time in which their labor has not been counted for gain. Not so with the farmer. Other professions can put off the work they should do without bringing ruin to their business, can work harder and catch up again, but not so with the farmer. The seasons cannot be put off with promises, and crops to be of value must be first planted, and then looked after that the tares do not creep in and multiply seven-fold, to the utter destruction of their hopes and their crops together. The farmer must be ready every time to take advantage of the seasons, if not they will get the advantage of him, and "poverty" without "peace" will be his portion. To do this requires good health "from New Year's bells to Christmas chimes."

A HEALTHY CALLING.

Why should not farmers have good health? The out-door life, the good air, the delightful contact with nature in her purest and noblest forms, the uniformity of their hours of labor, in fact of their life, especially their hours of repose. That independence and self-reliance so different from the feelings of those that depend upon others and meet with a continual round of disappointments from faithless servants, makes farming, it would seem, one of the most healthful as well as the most delightful occupation of earth. Why should not farmers be healthier and longer lived than any others?

We must admit that statistics are against us, for they are not, and

figures don't lie. They say that lawyers, doctors. and ministers outlive the husbandman, and there must be a reason why. I know I am treading on dangerous ground when I criticise your

HOME LIFE.

But I too well know that all through this State, which perhaps by nature is as healthy a section as there is in the world, there are among the farm homes a violation many times of the known laws of health, even such laws as the school boy of sixteen well knows how to rectify. Still those violations go on from generation to generation, and death too often claims its victims unchallenged, and the nuisance is unabated. I give you fair warning that I have not taken this subject to tickle your fancy or flatter your vanity, and I propose to speak "right out," let it hit who it will. I shall make this plea for healthy homes for the sake of women; for that saintly mother, that Christian like brings up her children, suffering herself without a murmur, watching by the bedside with her little one, sick perhaps with diphtheria or typhoid fever, the result of sanitary laws disobeyed.

Man's life is in the field where he breathes the pure air of heaven. Woman's in the house where she is too often compelled to drag out a life of ill health and discomfort, with disease fastened upon her by her surroundings, from which there is no relief only in the grave. Oh! husband, brother! will you not think as you spend your life in the broader, grander, more diversified farm life called "out doors" of your wife, your sister in the unhealthful home tainted by the hog pen or sink spout, that your careless neglect has so placed that it contaminates the cellar, the rooms of the house, and perhaps the very water they drink, thus insiduously conveying the seeds of disease into their systems while you escape them.

As you come to your home hearty and bluff from the field to find a beloved wife, or may be a sister, nervous, worried, and sick in an unhealthy home, think of the possibility, nay probability, that the pain, the suffering, the nervous debility may be laid at your door, may result from your want of care, from your neglect.

SITE FOR A HOUSE.

Much depends upon this. It should be a spot of natural beauty, needing little labor to make it perfect. In this selection the farmer has great advantage as he chooses from his broad acres, and there are few farms that do not afford several beautiful building lots. How different with the inhabitant of village or city that has to select from such lots as may be purchased, and be crowded in close proximity with others. Having no power over his neighbor's premises, he is disabled at the start and must do the best he can, while the farmer can take the best there is in creation. Therefore let him choose the site on a gentle swell of ground if need be, declining to south or south-east, away from all swamps and wet places, remem-

bering that if you must support a frog pond that it should be as far from your house as possible, as it is quite certain that distance lends enchantment, even to the croaking of frogs; much more to the rising mists and gases of such a marsh.

THE SOIL

should be dry, not only on the surface but in the sub soil. If when you dig your cellar you find it damp change your site, for a damp cellar should never be tolerated. The researches of Pettinkefer of Germany, of Bowditch of Massachusetts, of Harris of New York, and other sanitarians, all agree to the fact that there are close relations between low forms of fevers and colds that bring consumption in their train, and the water line in the soil. You can never build a healthy home on a water soaked soil, no, not even on a sub soil in that condition. Your only chance is by underdraining, and that costs much money. But think; are not funerals expensive? Are hearts robbed of their first love indicative of future happiness? Change your site for a dry one or underdrain if you prize life, health and happiness.

WATER.

Pure water is the necessary beverage of man. Before a blow is struck on your house, and as soon as you have found your dry location, look out for water. Here in Vermont the bubbling spring is generally conveniently near, and the greatest of all luxuries is an unfailing stream of soft water, but as you bring it, carry it away, never allowing it to run waste near your house. If you are less fortunate dig a well; but remember that wells usually drain a surface in form of an inverted cone, the diameter of the base twice the depth of the well, and its apex at the bottom of it, sometimes much larger. See to it that it is so far removed from house or outbuildings that by no possible chance sewage or other foul water can ever get in it. I have examined well water from some of the best farms in Vermont to find them contaminated and really unfit for use. But how disgusting to think that we make use under any circumstances of water contaminated with sewage or drippings from the barnyard or stable. Do not say your water is clear and good. It may be clear and not clean; clearness is not test of purity. But Dr. Kedzie gives a simple test; try it and see for yourselves.

TEST FOR PURE WATER.

"Fill a perfectly clean quart bottle two-thirds full with the water, dissolve in this a teaspoonful of the purest white sugar, cork the bottle and set away in a warm place two days. If it remains clear and bright you need fear no evil; but if it turns milky white and gives off any offensive gases, beware how you drink the dirty stuff."

This is applicable to old wells; and the location of new ones should be improved by paying due attention to the dangers of the old.

PLAN FOR A HOUSE.

I do not here expect to give anything but general directions. It should be convenient in size and relation of rooms, and the kitchen should always be the most pleasant room in the house. The house should face southeast, that the sun should find easy entrance. But you will say, how strange! would you set the corner to the highway? Surely I would, and the back corner too, if necessary. Are we so fearfully a right angled people that we must sacrifice our health and often our lives to that dogma. Let the house stand as it may, I would have the living rooms upon the east or southeast, that the early rays of the rising sun would penetrate that home and give life, light and warmth to its inmates. Then it will be cooler in the after part of the day when the warmth of the sun is not needed. Even in the warmest summer time the mornings are often chilly in this old Green Mountain state, when the hot afternoons with sun blazing into our living rooms would be almost intolerable. Then our cold winds of winter, usually from the northwest, would be shielded from the living rooms which the sun would render more cheerful. By proper arrangement of spacious grounds it does not matter how the house stands with the highway, for to all it will be a beautful spot.

SHADE TREES.

These are often condemned without a hearing. We should have shade trees. No home without them is as healthful and pleasant as with. But they should not shut out the sunlight, but be mostly on the west, northwest and north of the house. Not too near, nor yet too far. Not near enough to darken the windows when large, but near enough to shield the house from northwest winds and give a delightful coolness in summer. There may also be trees upon the south, but not in such way that they will prevent the sun from shining direct into the house as first mentioned. Damp cellars may be made better by shade trees, as they evaporate much water from the soil. Evergreen trees upon the northwest, if set so as to form a protection from northwest winds, are very desirable. If your shade is too great a dampness must and will come into your homes and the remedy will be to lay the axe to the root of the offending trees, but I would advise all to cut them with caution, for a good shade tree is the product of years of growth and if cut away your lifetime can seldom replace it. So cut no shade trees rashly away

MATERIALS FOR A HOUSE.

In this State, houses are usually built of wood; yet a few are of brick. Of course the wood house is the cheapest, but for many rea-

sons brick is the best, yet in consideration of the cost as yet wood will be the usual material. A brick house is cooler in summer and warmer in winter, is not so liable to be destroyed by fire, and if properly built does not require so many repairs. I often hear said that brick houses are the cheapest in the end. Again, as air passes very readily through brick and less so through wood the brick is more conducive to health for the reason that the walls ventilate the house to a certain extent. But you are surprised at the fact that air passes through brick walls. If you will take the trouble to try a few experiments you may be surprised at the results. Make a cylinder of common lime mortar or of brick three inches in diameter and five or six inches long. Cover the sides with gummed paper; make two tin caps to go on the ends, and in the center of those caps have a tube the size of a pencil. Make the caps air tight by putting around their edges a strip of the gummed paper, sticking it to the paper on the cylinder. Now, blow in one tube and you will see that you can blow out a candle placed at the mouth of the other, and shows you how readily air passes through the brick walls of your house, or the plastered walls of your room.

If you wet the brick or mortar little air will pass through, showing one of the reasons why damp houses are unhealthy.

But this experiment may be much simplified. When I was a boy I used to make blowpipes of tobacco pipes. Heat the end of the pipe stem almost red hot, then crowd the heated end into a lump of hard putty, and by a twisting motion you can closely fill the stem. Take a fine needle and make a hole through the putty when hot, and you get a good blowpipe jet. It is the boy's blowpipe everywhere, and is for most purposes as good as any.

After fixing a dozen pipes in this way fill the bowl of each half full of wet tow, or a bit of wet sponge will do, then fill the bowl full of well tempered lime mortar, and strike off even with the surface, putting your pipes one side to dry. When fully dry take a small flame and one of your pipes and see how much you can sway the flame blowing through the mortar. If not too large you can extinguish it. Now, wet the mortar and you cannot sway the flame, as no air passes through plaster when wet. It has been estimated that with a difference of 20° of temperature between the outside and inside of a common plastered wall ten cubic feet of air each hour may pass through every square yard when dry.

Prof. Marker and Shultz show that at least eight cubic feet in the same time will pass through the walls of a brick house. Hence, it may be seen that your walls breathe, thus giving you health through pure air.

That air passes readily through plastered walls is demonstrated in every home where the plastered surface has been undisturbed by whitewash for several years. As you look at that ceiling you can see the outline of every lath by its ligher color, while the cracks between are several shades darker. The reason is that the plastered wall acts as a filter, catching and holding upon its surface the particles of dust with which the room was filled, as all of you have noticed when the last ray of sunlight came into your rooms, that

particles of dust were dancing in it. This dust is left behind to color your wall. Where the timbers are, the color will be still lighter, showing that while the lath arrested the circulation much, the timber did more, and so the posts and braces can usually be made out though entirely covered with mortar. Now let us take another pipe and whitewash the surface of the mortar, while it is wet you cannot force air through, when it dries you can, showing that whitewash does not close the breathing pores of the mortar.

Let us take another pipe and kalsomine the surface of the mortar. When dry we find we can blow through it slightly, but not as much as before. So kalsomine keeps clean longer than whitewash because it does not allow so much air to pass through it. Now, let us paper one of our plastered pipes and we find whether wet or dry we can force no air through it. Thus you may see why papered walls are warmer than plastered walls, and yet are not as healthful. Dr. Kedzie say: "The tidy housewife looks with contempt upon whitewash, because it gets dirty so quick, while she feels proud of her kalsomined wall because it keeps clean so long. The one gets dirty because it breathes, the other keeps clean because it does not breathe. The dead baby's fingers when once washed keep clean, but the live baby's forever find dirt."

Which is best I need not tell you. A healthy house needs breath nearly as much as an animal. A papered wall, a painted wall and, I will add, a kalsomined wall, is like the dead baby's hand. A plastered wall is a healthful wall.

Our skin is perforated by millions of holes which we understand ventilate the body and our health depends upon keeping such pores in perfect condition. It is true we have a breathing apparatus upon a large scale, and so a house needs a special ventilating apparatus. Our clothing is all porous, and you can easily extinguish a light by blowing through the thickest overcoat; yet we can have rubber clothing, but all know how very uncomfortable it is. The reason is it is not porous. Every healthy garment must be penetrated and washed with air to preserve health. The house is only a huge overcoat. I bring out the points in this way that they may be understood.

While wood admits of the passage of air lengthwise, but little passes through it sideways, and that little in our homes is usually prevented by paint, but we depend upon the shrinkage and careless joints of the carpenter for air, and he does not disappoint us; yet the walls of a house may be too open. They should breathe, but never blow.

HOMES RAT PROOF.

When you build, always secure your structure against vermin; keep out surely the rat and mouse. They are not welcome visitors; are not conducive to health, and are also costly boarders. A little care by putting an inch of mortar between your partitions and at your ceiling is all that is usually needed.

But I am often asked how they can be kept out when a house is not properly built. I had the misfortune to purchase such a house,

and after being tormented for years I put fine ground cayenne pepper in all their raceways, and the rout was complete. I do not often renew it) perhaps once in five or six years), and have no trouble. I think it a good remedy.

HALF STORIES.

I should build no half stories to be like an oven in summer and cold and damp in winter. It costs but very little more to build two stories than a story and a half, and if you finish up, as some do, with many angles in the roof, the cost is even greater on half stories. In an ordinary farm house, fifty dollars will pay all the additional cost. Then you will have the comfort of cool, airy chambers; in fact the second story will be the most pleasant part of the house.

VENTILATION.

Plan for this as you would for your chimeys, and if you build your chimneys large enough you can well ventilate into them; but if possible have a fireplace in your living room—not a fireplace to look at, but to use. Nothing is more cheerful than a fireplace. "It fills the humblest room with warmth and glory." It is the best ventilation you can possibly have. The atmosphere of any room cannot be impure with a fireplace in which there is a fire burning. In some way ventilate every room in your house. I cannot do better than to use the words of Dr. Kedzie, who says, in his lecture before the Michigan State Board of Health:

"I ask you to do this, first, because there is plenty of raw material for this purpose; and, second, because it is necessary for health. Think what an abundant *circulating medium—current cy*—we have for this very purpose in atmospheric air. Fortunately, Congress cannot expand or contract the *circulating currency of life!* This ocean of air—an ocean without island or shore, with its restless tides and currents, its waves of continental size—is too vast and pure for us to contaminate it in mass. We may pollute here and there a puddle of it, but its massive purity is, like the love of God, too great for human defilement. This purifying element penetrates, directly or indirectly, every fibre of our being; it washes, purifies, and saves us every moment of our lives, from birth to burial.

Yet how we fight against this agent of purity! In the arrangement of our dress, in parlor and bed chamber, in school room, church and hall we seek to exclude it, and to stifle it as if it were our deadly foe. We breathe it only because we must, and most of us breathe it as little as possible. Thousands of consumptives every day go weeping to their graves only because they would not breathe enough pure air to keep their lungs healthy. Yet this purifying and saving element is ever seeking to enter our dwellings, rattling at our windows, searching every crack and opening by which to enter to give us life and health; but if by chance it enters, we only complain of

the draught; if any friend opens a door or window to let in this cheerful guest, we sarcastically ask him if "he was brought up in a saw mill!"

Air once breathed is unfit to breathe again; turn it out to grass, like Nebuchadnezzar, that it may recover its soundness, for vegetable life repairs the defilement and destruction caused by animal life, and restores sweetness and health to polluted air. But this contamination of air by respiration is invisible; neither sight nor touch will reveal its presence. The black and sooty carbon, when it has seized its two wings of oxygen, becomes totally invisible, and floats unseen like a spirit. If this carbon, thrown off from our lungs in the form of carbonic acid, remained visble like lampblack, there is hardly a housewife in the land who would not awake with a gasping shudder to see her bed room filled with this black smoke sent off from the lungs of the sleeper. "Up with the windows, and clear out this horrible black dust!"

But because this dirt is invisible, she regards the air of her room as clean. But though it lurk unseen, its power for mischief is not destroyed; it is the accompaniment and evidence of contamination which proves the unfitness of such air for respiration. The carbonic acid itself "is a slow poison, and kills with indefinite warning." If the housewife wash her hands in water, she does not say, "the water does not look very dirty, and I can use it again." No! the water was used to remove dirt, and has thereby become dirty, and she throws it away. Shall she wash her hands five or six times a day with clean water, and wash her lungs 28,000 times a day with dirty air? "Be ye clean," is the voice from heaven, sounding forever through the ages. Your bodies are the temples of God: "if any man defile the temple of God, him shall God destroy," is a physical as well as a spiritual truth, and millions upon millions of premature graves bear witness to a judgment day already come, and to a doom from which not even the Infinite Father's love could deliver them. "The soul that sinneth shall die," unless saved by Christ's love. No less true is it that the body that sinneth shall die; and to justify this broken law and make it honorable, no Savior has been crucified. If, while locked in the arms of sleep—the twin brother of death—you constantly breathe deadly gases, instead of the breath of life, then shall sleep hand you over to the embrace of his twin brother.

But you will say "How can we tell whether the air of our bed-rooms is pure or not? We are not chemists to analyze the air." Why, man! woman! You have the best apparatus in the world, and one given you for that very purpose. Nature has given every one of you a *nose*, and purposely placed it in advance of all the rest of the body to give you warning of danger; it is the advance guard of safety! If you will use this "one talent" which nature has given you, and not "keep it wrapped in a napkin," you may go safely. Use your blessed nose for this purpose to-morrow morning to test the air of your bed-room. When you get up leave your room just as it was; go out into the pure morning air and breathe that till your nose is wide awake, and then go back and take a few snuffs of your bed-room air; if it smells fresh and sweet like out door air you have

good ventilation, and have breathed the breath of life all the night. But if it is close, musty and sickening, beware. Try the experiment by all means, and see how much your nose can tell you. Perhaps it may give you some idea of the cause of your waking with a headache and languor, feeling that life is a burden. It is a burden when you carry such a crushing and needless load.

But you will say, "What can I do? There is not a ventilator in my house." No ventilator! while that is one of the first things to provide for in planning a house. What did you build your house for, to live in, or smother in? Judged by what men aim at in house-building, we should conclude that houses are mainly planned for smothering. But thanks to poor carpentry, which leaves cracks and openings everywhere, thanks to the penetrating quality of air which pierces brick, mortar, wood and everything of which houses are built, except metals and glass, every house has some ventilation, however poor. But this is not enough, and we need by some more direct means to cast an anchor of hope into the ocean of life outdoors. An old writer says, "When men lived in houses of reeds they had constitutions of oak; when they live in houses of oak they have constitutions of reeds."

The patriarch, before the flood, whose life stretched out into centuries, was a dweller in tents; when we come down to the time when men left the airy tent to dwell in ceiled houses, we are told "the days of our years are threescore and ten; and if by reason of strength they be fourscore yet is their strength labor and sorrow; for it is soon cut off and we fly away." Is this the final verdict in the great chancery suit of Tent *versus* House?

Look around your neighborhood and see how many men lived in vigorous health while they lived in their poor houses, well ventilated because poorly built, but when wealth accumulated and they built good houses, they sickened and died. You say, "how sad that neighbor Jones, who was hale and hearty all his life, just after he moved into his new house should die and leave all he worked so hard to secure!" Yes, thanks to the skill of carpenter and mason, he smothered at last.

Every bed room has or should have a window: and when you open the window you will find the out door air immediately on the ontside, and ready to enter at a moment's notice. "But we shall freeze with the window open! and then the night air!" As well freeze as smother. Is your bedroom air, that you have breathed over and over better than night air?"

Yet, as Angus Smith says, "a blast of cold air may kill like a sword," and that is too true and between the two extremes it may be hard for some to hit the happy mean. To such I would say that very good window ventilation can be obtained by raising a window about four inches and placing under it a closely fitting piece of board. This prevents any draft from coming directly upon any person in the room, but the space between the glass and sash at the middle of the window will bring in a current of pure air to mingle with the vitiated air of the room and such ventilation is of great advantage. The

growing of plants also, especially such as do not require a large amount of water, are very beneficial, as thrifty growing plants give off the oxygen which we so much desire and use up the carbonic acid which we have no use for. Where you have ventilators see to them that they are in working order. A majority of supposed ventilators are

"As idle as a painted ship
Upon a painted ocean."

It is not necessary that they should be at the top of a room to carry out all the warm air, but like a fire-place with good draft. There are various means of ventilation and many hobbies connected with it with which I do not care to quarrel, but allow me to say that warm air is not vitiated air and it is not necessary to use any person's patent to gain good ventilation when you build, but for houses already built it is often a question of importance; and I have found that with the board under the windows and a grate connected with the chimney draft where you would naturally put a fire-place, if you had one, the cheapest and best arrangement for the money.

A bed room in which there is a stove can be quite well ventilated by putting a burning lamp just within the stove, with the stove door open; letting it burn through the night. The burning lamp causes draft and that draft of course takes out the foul air while the plastered walls and the cracks left by the joiner supplies fresh. The impurities in your living rooms, are usually caused from the cooking of food, the expirations from your lungs, the decomposing vegetation in your cellar, the lamps you burn, and the exhalations from persons occupying the rooms. Sometimes the cellar is foul from other causes. Carbonic acid collects to such a degree that a lamp placed on the cellar bottom will burn dimly if at all, and the continued diffusion therefrom makes the atmosphere in all your rooms deleterious. Such contamination is controlled by laws of nature and not the ruling of man, as I have often found it worse where chemical rules made by man should have it best; but you may be always sure of one thing, and that is that your cellar if not properly ventilated will cause you much sickness and trouble. If you have a chimney in it ventilate into that surely, and provide some way for fresh air if possible. I have traced much disease to cellars, and I feel I cannot enough condemn the filthy way in which many farmers allow their cellars to be in. See to it, for it is much cheaper to keep your cellar clean, your sink spout covered, and your house well ventilated than to pay the doctor's bills and the bills for nursing, that bad cellars and bad ventilation entail. Keep your cellars free from mould, lest that mould seize upon the very sills of your house and spread rottenness all through. A damp cellar and rotten timbers foretell wet eyes up stairs. Drain and underdrain the soil about your house until your surroundings are always dry. Use whitewash in which you put sulphate of lime or some disinfectant until your cellar is the pattern of purity.

If you neglect those things the angel of death will not pass you by, but spread his wings over your household, and that mys-

terious providence of which you speak will remove the loved ones and bring sorrow. But do not charge it to providence, but to your own laziness, that allowed diseases to be daily invited through your slovenly neglect. "A prudent man foreseeth the evil and hideth himself; but the simple pass on and are punished." But you say,

ARE FARMERS SINNERS

above all others? Remember what I told you of statistics, that show the average life of the professions are longer than yours. They attend to those things better than you; yet there is great chance for improvement everywhere. But the hope of the republic is in the farmers. It is there we look for recuperative power, and so there more than elsewhere the great reformation should begin.

OUR FOODS

also need close attention; that in what we buy, we may purchase what we desire to eat, and not be paying for what we do not wish to have. But the man that was hit when we spoke of adulteration one day says, "There never was a time when pure articles could not be purchased if we would pay for them." And that may be true; but does anybody know what glucose is good for? So far as the public is generally informed it is only used as an adulterant. Mixed with sugar it makes an inferior article and enables the mixer to impose upon the public and make money. The same is true of syrups. The refuse from the glucose factory makes the cows give thin milk, and we would like some one to tell us just wherein it is used for any good purpose. Great factories are built for its manufacture, and their proprietors appear to make a great deal of money, but the glucose is not advertised for sale, nor does it appear in the open market to any observable extent Those who buy and handle it seem to do so in a surreptitious way. It travels under assumed names. It goes in at the back door and never goes out at the front door until it has changed both its character and name. The whole American people are said to be eating glucose, yet not one out of a thousand ever saw or tasted it under that name. If it can build fifteen-story buildings and add millions to the fortunes of millionaires, why should it hide its head in shame and avoid the scrutiny of the public eye?

We can buy pure sugar, but does the farmer always know that he gets it?

In a manual published by the "American Grocer Publishing Association," of New York, the writer says: "The adulteration of goods of all kinds is extensively carried on, and so general has become the practice that it is almost impossible to obtain pure manufactured goods. Even the articles used for adulterating purposes are themselves adulterated, and the evil has no limit." But we will pass a few in review:

COFFEE.

"This is largely adulterated with roasted chiccory, corn, beans, lupine seeds, peas, pulse, horse chestnuts, spent coffee and various roots, such as carrots, parsnips, beets, dandelion, etc., and it is said spent tan bark and bullocks' liver are employed for the same purpose." The test that farmers can use is as follows: "Scatter the supposed coffee on water. If pure, it will mostly float on the surface. If impure, the most of the impurities will sink in the water and soon discolor it, while coffee discolors very little. So much for ground coffee

Of course this would seem to show that it would be better to buy the whole article. But P. H. Felker, Esq., of Grand Rapids, says: "There is a machine patented in England for making spurious coffee berries out of common vegetable substances," and we hear of another producing glucose berries which are a perfect imitation. Does this mean anything?

TEA.

This is extensively adulterated in China by exhausted tea leaves, and leaves of other trees, especially the willow; to the amount of millions of pounds annually. Mineral matters are also used for coloring and facing teas, and coffee. China clay, fine sand, iron filings, etc., are sometimes used, as the *Grocer's Manual* states, to the amount of "20 to 40 per cent."

The adulteration may be determined by those who wish to examine by soaking out the leaves and examining them, noting their shape, etc., while the dirt and mineral matter will in part settle in the teapot. Teas are also "doctered," as it is termed, in this country, but not to such an extent as in China.

CREAM TARTAR.

This is often largely adulterated with common land plaster. Test, dissolve in water and note what is left, as the cream tartar will readily dissolve, and the adulterant dissolves slowly.

GINGER.

Ginger is extensively adulterated with Indian meal, starch, wheat flour, mustard husks, etc. It is then flavored with cayenne pepper to give it apparent strength. The microscope detects the cheat very easily as it does in all fine ground goods.

PEPPER.

This is largely adulterated with buckwheat hulls finely ground, and other worthless substances. The microscope is the sure detective.

Thus I might go on through the entire catalogue, but space forbids, and I will only say that even lard and butter are not exempt from the general rule. The evil can be remedied by every farmer's demanding a pure article and being willing to pay a fair price for it. The grocers say they are compelled by competition in prices to reduce the standard of their goods, and no man can expect to buy a current dollar for ninety cents. So leave off crowding down prices and insist upon excellence instead, and you will be more cheaply and better served. Buy of responsible parties, and then insist on purity, and you will usually get very good articles, at least.

There is needed reform here. See to it that, while you are honest yourselves, you insist upon honesty in others. If the articles you sell are contaminated with fraud, first cast the beam from your own eye that you may see clearly to cast the mote from your brother's eye.

MINING IN VERMONT.

AN ADDRESS

BEFORE A MEETING OF THE

State Board of Agriculture

MANUFACTURES AND MINING,

AT BURLINGTON,

BY

HIRAM A. CUTTING, A. M., M. D.,

STATE GEOLOGIST AND CURATOR.

MONTPELIER:
POLANDS' STEAM PRINTING ESTABLISHMENT.
1872.

ADDRESS.

Mr. President, Ladies and Gentlemen:

In the meetings of this Board, though the principal interests are rightfully directed towards agriculture, as Vermont is truly an agricultural state, yet, as we have a manufacturing and mining interest, represented by a large and constantly increasing capital, it is but just that they should claim attention. It is of our mining interests that I shall speak, not with the flattering terms of a speculator, or a dealer in mining stocks, but with due regard to truth as unfolded by geological science. And while I do not intend in any way to prevent the due development of mines in Vermont, I hope I may discourage useless expenditure, and thus tend to elevate mining from a mere guess to what it in reality is, a true science.

Our mining interests in marble and slate exceed that of most other states; perhaps I might say any others, but in metallic ores, of which I shall more especially speak, our rocks are too old and compact, or too nearly connected with the glacial drift, to have many mines of great value or extent. Our mountains of lead, silver or iron, notwithstand-

ing their traditional substantiation, do not exist in fact. The mining interest of Vermonters is, however, quickly aroused. When I have made enquiries in a place in reference to any mineral, I have frequently heard some old legend about an Indian that obtained lead for bullets from such a mountain, or an old Spaniard who procured a great amount of silver from a certain side hill that they had often looked over in vain, yet believed there was truly a silver mine there. The express frequently brings me sand containing yellow or white mica, while the one sending it indulges the vain hope that it is gold or silver; and white and yellow pyrites in schist rock is quite as often at hand. Now and then, however, a specimen reaches me that really contains galena, or copper pyrites, and sometimes an almost microscopic speck of gold, but of such a quality, or so sparsely scattered, as to be of no value whatever. Though we have much of the early formation, or Eozoic rock, it is in Vermont that the drift agencies come in full play, and it is difficult, many times, to unravel, even by supposition merely, knotty questions that come up as we investigate the drift problems. Drift scratches in the primary rock frequently cross each other, at various angles, and the glacial and iceberg theories must both be called in to remove the difficulties, and even then lingering doubts will creep in that other forces, not well understood, might cause the almost unexplained freaks of geological contradiction. At Brandon the drift is frozen, and after various opinions are expressed and ingenious probabilities formed, such naturalists as Prof. Agassiz say "that it is a fact standing forth, perhaps without true explanation as yet." Here and there what might have been valuable beds of ore, as in Arlington and Manchester, have by this agency been torn from their original positions to be broken and scattered in such small masses as to be nearly worthless,

and well skilled miners are thus foiled, and capital many times wasted. Mining for metallic ores in Vermont, as it has been carried on, has hardly been far removed from a game of chance, and I doubt if all the profits of the truly productive mines would pay for one half of the time and money expended to no purpose. Indications, that in some sections of our globe would lead invariably to valuable mines, pass for nothing in Vermont. Though we have the representative rocks, from the Eozoic to the Tertiary period, sufficient to indicate the possibility of finding any mineral, with the exception of coal, yet they are so compact and closely jointed that truly extensive beds of any ore must be the exception instead of the rule, and for this reason extreme caution is indicated in investments.

It is true that some mines of iron and copper have at certain times, and do still, pay a profit to their owners; yet the record of disaster in comparison is fearfully large. In some sections much money has been expended in the vain search for workable ore in the drift formation. In other sections shafts have been driven, as at Ludlow, where the most common knowledge of geological science would have saved thousands of dollars. With such examples at hand it seems evident that the work of the geologist should be something more than to point out probable mines, and encourage capitalists to make investments for developments, but rather should dissuade rash persons from rushing blindly on, where experience has proved that failures must result. I would in no way depreciate mining with a probability of success, but would reduce this needless expenditure, which in Vermont has been fearfully large.

Gold is widely distributed over the globe, and occurs in rocks of various ages, from the Eozoic to the Tertiary. The schists that contain the auriferous veins were once sed-

imentary beds of clay, sand, or mud, derived from the wear of pre-existing rocks. Through some process in which heat was concerned, the latter were metamorphosed into the hard crystalline schists, and at the same time upturned and broken and often opened between the layers, and then all the fissures cutting across the layers and the openings, (made between the layers, and therefore conforming with the lamination,) became filled with the quartz veins containing gold.* The quartz was brought into the intersecting fissures and the interlaminated open spaces, from the rocks either side, by means of the permeating heated waters, at a temperature probably much above that of boiling water, having thus great decomposing and solvent powers, and carrying into cavities whatever could be gathered up in this manner from the rocks. Thus it will be seen that the gold of the veins was derived from the rocks adjoining the openings, either directly adjoining, or above or below them. According to this idea, which is believed to be correct, it must have been widely distributed through these rocks before they were crystallized and the veins were made, although it existed in so infinitesimal a quantity in a cubic foot, that the beds without this metamorphision and the vein-making would have everywhere been worthless mining ground. As we have before said, gold exists more or less abundantly all over the globe, and in most of the regions of crystalline rocks, especially those of the semi-crystalline schists, like those in central and eastern Vermont, it is sometimes wrought with profit. Those gold-bearing schists are interspersed with quartzy seams and veins, in such a way that the gold miner from Siberia, or even from the Sierra Nevada of our western coast, would pronounce sure indications of richly productive mines. Further, gold actually exists. In some towns

* See Dana's Mineralogy, page 7.

situated in the central talcose schist section, as Plymouth for example, gold has been taken in paying quantities, yet in other sections with little or no success. In 1866, at Bridgewater, quartz mining was carried on to some extent, and the veins seemed more promising than any others in the State, but they were soon given up, though assays from selected ore show from $80 to $100 gold per ton of ore. A regular yield of $10 per ton, with favorable rock to blast, would certainly be profitable, but blasting was not a success in Vermont. In 1868 and '69, certain parties in Lisbon, N. H., on the line of talcose schist, which I have spoken of as being largely prominent in eastern Vermont, formed extensive mining companies, which companies erected two mills, or crushers, for the elimination of the gold from the quartz veins in which it was found. The stories told of the amount of gold obtained would do credit even to the gold regions of California; yet after running a few months the proprietors became involved, and their property was sold at auction at a small percentage of its cost. The present proprietors, after carefully looking over the mining prospect, turn their attention towards agriculture, and believing their interests lie in that direction, crush the rock so poor in gold as to be worthless, and sell it to farmers as a plant food, superior to superphosphate or guano. That they now make profit I do not doubt, but that farmers derive a benefit therefrom, at all proportionate to the price paid, I do doubt, and if chemical science is not in fault, the "Stevens Fertilizer," so called, ground from this rock, is no better than so much fine sand.*

* In the Boston Journal of chemistry, page 89, the editor says: "It seems the Lisbon fertilizer is now fairly pitted against the Grafton, and in the contest it will be interesting to learn whether the silex of the former, or the dolomites of the latter shall come out ahead. We give the analysis of these fertilizers, for which we make no charge:

GRAFTON MINERAL FERTILIZER.

Silica.....30.30

Prof. Collier, in his analysis, may show the "Grafton fertilizer" of more worth.*

But the gold panic did not stop in Lisbon: almost every man that owned a farm within the schist district, felt more or less the gold fever, and nearly all wasted both time and money in the fruitless search. Not because they did not find gold, was it unprofitable, but because they did, and the rocks so compact, with gold so scarce, that while it lured many on like a "will-o-the-wisp," it kept up the excitement in all, which has hardly subsided as yet. It is possible that gold will be found in Vermont in workable quantities. If so, it is probable it will be in the central district, or in sand on the bed rock, as our quartz veins seem too hard to promise well. †A young man in Essex county, brought me a

Protoxide of iron	6.27
Lime	20.60
Magnesia	11.17
Carbonic acid	32.11
	100.45

LISBON, OR STEVENS MINERAL FERTILIZER.

Silica	90.60
Lime	3.27
Oxide of iron	3.06
Alumina	.31
Magnesia	.38
Carbonic acid	1.35
Water	1.06
Alkalies	a trace.
	100.03

Good solid plant food truly. It would be as unreasonable for a baby to turn away from cast iron, as for the grasses and cereal plants to reject such delectable nutriment as is here afforded."

*See Prof. Collier's analysis of the Grafton and Stevens mineral fertilizers, in Report of State Board of Agriculture, &c., 1872.

†Gold has since been found near the village of Gaysville, and it is said the washings pay, and are quite extensive, under the direction of Saltery & Smith, the lessees of an island in White river, near the above mentioned village.

Assays of gold from localities in the vicinity of Gaysville show it to be very pure, a sample from "Locust Creek" containing 94.74 per cent. of gold, and a sample from the "Island" containing 96.53 per cent of gold. P. C.

fine specimen of gold from a rollstone he found, while digging a well, and that specimen cost him much time and money, yet he never after found twenty-five cents worth of gold. Of course it is possible that gold may be found in workable quantities in the quartz of Vermont, but the probabilities are greatly against it. Now when agriculture is as remunerative as in this State, will any reasonable man take that small chance of prospecting our rocks for gold? Better (than to largely invest in quartz mining,) plant corn and use the poorest mineral fertilizer in place of guano, and at the same price, if they must be humbugged.

Chalcopyrite or copper pyrites, a valuable ore in many countries, as England, for the production of copper, has been found in many sections of this State, and new veins are liable to be discovered at any time. Its being wrought with profit, however, in this section, is quite another thing, as it requires the most favorable circumstances for success. Where one venture has yielded a fair compensation, many have been failures, even when the managers have supposed every indication of a favorable character. There appears to be three divisions or belts of copper bearing schists, extending into this State, one in the eastern, one central, and one western. The eastern belt, crossing the Connecticut in the southern part of Essex county, was unknown until 1864, when it was discovered at various points and mined in several places. The most extensive mining operations were carried on in the south part of Concord. A company of New York men purchased the almost barren hill at a cost of about thirty thousand dollars, erected buildings and necessary machinery, expended twenty-five thousand dollars more in mining, obtained about twelve thousand dollars' worth of copper ore, and then abandoned the enterprise. The vein was well situated, but quite variable in thickness,

being sometimes six or seven feet, and again but a few inches, with a hard quartzy, gangue rock. At a depth of about one hundred feet it seemed to run nearly out, or be found only in irregular lodes, and was given up. It is, however, quite probable that other outcrops of Chalcopyrite may be found in the copper divisions of Vermont, that can be wrought with more or less profit, but the history of those previously wrought should lead every one inclined to invest to weigh well the probabilities and take counsel of past experience, as well as to obtain accurate information in relation to the character of the rock, and the probabilities of success derived from geological science. There is an old adage among miners, that "metals never grow in very hard rocks." As is often the case with practical men, the fact, as far as it affects mining, is correct; but of the growth of a mineral, of course, it is obsolete.

As tin, if found at all in Vermont, will doubtless be found in connection with the copper mines, it will be well here to direct our attention to that mineral. Many tin mines now wrought in different sections of this globe were explored for, and several wrought for copper; and in a number of cases it was only several hundred feet from the surface that tin was first met with. Some of the tin mines of Cornwall, which are the richest in tin of any on the globe, were first opened for copper, though after reaching the granitic rock tin was found. In the Vershire copper mine, when visited by myself in 1867, indications of tin in the deepest shaft were quite prominent, and I find the same opinion was expressed when the mine was examined by our State survey in 1859. As a gentleman from Bradford will present a full description of this mine before the meeting, the present prospect of tin will doubtless be discussed.

As tin in Vermont can hardly be expected unless at the bottom of a copper mine, prospecting for tin on the surface would be useless expenditure.

As regards lead, though we have certain indications which would in some sections make probable the existence of valuable mines when opened, there is very little probability of any richly paying mines in this State. The sulphuret of lead is the principal ore from which the lead of commerce is obtained. Doubtless the most important mines to-day known are those in the States of Illinois, Wisconsin, Missouri, and Iowa. Lead is there found in a porous, magnesian limestone, and all around, in and about that region, it is fissured into caverns and openings of various kinds. Frequently those caverns are found incrusted with beautiful crystals of sulphuret of lead in fantastic forms. We have in Vermont undisturbed beds of Silurian rocks, some of which are nearly identical with the galena, or magnesian limestone of the west; but in these compact and comparatively undisturbed sedimentary rock formations of this State, there is hardly a trace of lead. Some small veins of sulphuret of lead are, however, found in the metamorphic rocks of the State, but in no case as yet in sufficient quantity to warrant any great outlay for its extraction, and I think the ill success of the Thetford hill mine, as well as small veins elsewhere, that have taken tribute from men expecting riches from mining, should prevent any further rash expenditures in this section. Yet as many lead mines exist in metamorphic and even in igneous rocks, should sulphuret of lead be found, it would be well to call science in to aid in an opinion as to its worth.

Silver, if found in workable quantities, will doubtless be in connection with lead; small grains of metallic silver may, however, be found in quartzy veins, but cannot be ex-

pected in workable quantities. A small quantity of silver was found in the Thetford lead mine, and I have now specimens from an unopened vein in Weathersfield that contain silver as well as lead, but it is not in remarkable quantities in either place. It would be well in all cases to assay for silver as well as lead, and though these mines would hardly pay to cupel for silver, others might, as I am informed that one dollar and fifty cents per ton will pay the cost of the Pattinson process. Yet I will further state that workable mines of silver or lead are hardly probable, and all should, therefore, invest with caution. I often have my attention called to white iron pyrites under the supposition that it is silver. That the schist rocks of Vermont will ever afford in their substances large amounts of metallic silver is beyond the range of probability, and all that are sanguine over such specimens would do well to inquire what Dr. S. R. Hall means by "fools' silver,"* before they ask many questions. Disappointments would then be more rare. In quartzy sections the probabilities would be greater, but mica there might lead astray.

As regards iron, it occurs in rocks of all ages in workable quantities, and in nearly every portion of the earth's surface. Of course Vermont, with its mountains and valleys, and variously contorted strata of early formation, would not be likely to be without it. Yet this very early formation of sedimentary rocks tells somewhat against our mines of iron even. It being itself sedimentary, and not at that time as rapidly deposited as at some other periods, the veins do not obtain that extent or thickness that they do in many sections. Again many beds have in part been torn away by drift agency, and broken and scattered by various

* See Hall's Geology, Vermont.

causes, until their extent is rendered problematical, and many times the lode is so small that loss and disappointment to the miner results, as at North Troy and other places. I would also refer to Shaftsbury and Sunderland for further examples, where beds have been nearly all swept away by the drift. As might be expected, the more extensive veins of New York. together with the alteration in character of the gangue rock, rendering the ore more easy of access, and the ore itself less difficult to mine, tends to disparage mining in Vermont. Many ores of iron are, however, found in the State, and many mines have netted a profit to their owners. Among the ores, I would mention the brown oxide or brown hematites, as the most valuable for smelting, and in fine, it is most abundant. Earthy oxide or bog ore, is found in almost every town, usually in small deposits, so small as to be of no real value. We have also the red oxide or red hematite, the black oxide or magnetic iron, as well as the specular oxide, also sulphuret of iron, known as iron pyrites, useless except for copperas and the sulphuric acid manufactory, which brings so low a price in market that it is seldom very profitable to manufacture. We have also spathic ore, and the more valuable chromic iron, which is really of as much value as pig iron, as it is the base of those fine paints known as chrome green, chrome yellow, etc., as well as the bichromate of potash and other salts; it is, however, useless for the furnace. This chrome ore is nearly black ; having an uneven fracture, and a dull metallic lustre, it closely resembles specular oxide. It is found in connection with the serpentine of Vermont, or very near it, generally, and I think always thus far, in small veins, or crystalline masses. It seems more abundant in the northern part of the State, and all owning land over the serpentine section would do well to keep an eye out for chromic

iron. If found in sufficient quantity to warrant the manufacture of paints, the high value of the ore would make small beds profitable, as the ore could be sold without outlay for furnaces, etc., and when exhausted, no previous expenditure would be lost. The iron ores of Vermont, as I before said, have been smelted with profit in several places, as at Brandon and Plymouth : yet there has, doubtless, been more time and money wasted in various attempts to open productive mines, from worthless indications of iron, than all that was ever realized by those that owned successful veins. We can hardly expect to compete with the more valuable mines of Europe, or the mountains of iron in Missouri; yet as freight adds continually to the value of iron, the time will come when we can, probably, produce iron for home consumption at reasonable paying rates. I have no doubt but what many mines of iron now abandoned may be wrought with profit in the future. But all should beware of following worthless indications, or in any way expending money, until science or experience show a probability of success.

Carburet of iron, or plumbago, improperly yet generally known as "black lead," is found in several places in the State, but in small quantities and very impure. Perhaps there is no mineral sought for with such ill success as plumbago. There is often found on slate rocks a black tarnish which soils the fingers, and is taken by many, when found, as a sure indication of "black lead," (as it is termed,) and the ledge is blasted at considerable trouble and expense, when they find less and less of the supposed mineral, until at length the rock becomes compact, and all traces of it are lost, having been at first produced by the decomposition of iron pyrites, which may now be seen in shining cubes in the compact state. Again, such stained places, when dry,

have many times been supposed sure indications of coal, and the ledge mined for that mineral with no better success.

It may be well to say that the early sedimentary rocks of Vermont are altogether too old to contain coal, as they were formed before there was a sufficient soil upon the earth to give root to a vegetation luxuriant enough to leave the debris sufficient to produce the beds of coal, as found in other sections; and our glacial drift period on the other hand too recent to aid in any material formation of the kind.

Though we find at Brandon and some other places a faint effort of recent drift in the production of a kind of lignite, somewhat akin to coal, it is nowhere of great extent, and it is plain that it is entirely useless to expend any money in search of what cannot exist within our borders. Manganese is found in many places in connection with iron ore, and also separate therefrom, and is of use in the arts, bringing a fair price in accordance with its purity. It can never be any great source of profit to Vermont, as it is generally abundant, and it is doubtful if its damage to the smelting process, when mixed with iron ores, is not a greater injury than its value can ever compensate. But the worth of Vermont is not so much in its metallic ores as in its excellent soil, which reaches to the top of all our hills, and I might almost say, our very mountains. In the valleys and in our swamps is the best sphagneous muck, which needs only sufficient trial to become popular as a fertilizer. If, as Dr. Mason said at an agricultural meeting in New Hampshire, "the rocks of New Hampshire are the wealth of the State, as they only need to be pulverized to exceed the superphosphates in fertilizing power," we can safely say the same of our muck beds, which will do as much, and then add the fact, that our rocks are many times more valuable, whether used as monuments, building stone, or as lime to

burn and grind in a discarded gold crusher, to supply the farming community with a valuable, instead of a nearly worthless fertilizer.

I am asked if we need another geological survey of our State? I answer most emphatically that we do: not only to point out where mining operations can be carried on with success, but where they cannot; to enlighten the popular mind, so that the wild schemes of wealth from impossible mines may be crushed, thus saving waste of time and money, which might in agriculture give profitable results, as well as to point out differences in soil in different sections, and act thus as an aid to the farmer in determining what fertilizer is required to bring about the best possible results; to closely define the lines of division between soils of different characters, which can only be fully settled by a close study of all the geological changes which gave us this soil, though differing in different sections, yet found to possess extraordinary fertility everywhere within our limits.

REPORT

OF THE

STATE GEOLOGIST

AND

CURATOR OF STATE CABINET.

REPORT

OF THE

STATE GEOLOGIST

AND

CURATOR OF THE STATE CABINET.

To His Excellency JULIUS CONVERSE, *Governor of Vermont:*

SIR:—I have the honor to present you herewith the report of my management as State Geologist and Curator of the State Cabinet, since my appointment in 1870.

Through the inadvertence of the Secretary of the Senate for that year, the bill making a small appropriation for the improvement of the Cabinet, after passing both House and Senate, failed to reach the Governor in season for his signature and approval, thus apparently defeating the object in view, which object was the preservation of specimens already in the Cabinet, and the addition of such specimens as in my judgment I thought best to add thereto. Feeling that the passage of this bill by the Assembly gave me a sufficient guarantee, I have acted upon the intention of the bill, doing such work as I deemed necessary to preserve the specimens then in the Cabinet, and putting up in a proper manner as many specimens of the Ornithology, Oology, Craniology, Entomology, Conchology and Mineralogy of the State as I thought of sufficient value to warrant the outlay,

until my prospective funds were exhausted. Of the birds of Vermont I have added the following specimens:

No. of Specimens.				
	ORDER 1. RAPTORES, ROBBERS.			
3	Astur atricapillus	Bon	Gos Hawk.	
2	Falco Cooperi	Thomp	Cooper's Hawk.	
1	" sparverius.	Lin	Sparrow Hawk.	
1	" niger	Wil	Black Hawk.	
2	" borealis	Thomp	Red tailed Hawk.	
4	" pennsylvanicus	Thomp	Broad winged Hawk,	
3	" leucocephalus	Thomp	Golden Eagle.	
1	Accipiter fuscus	Lin	Sharped shinned Hawk.	
3	Pandion carolinensis	Bon	American Fish Hawk.	
2	Nyctale acadica	Bon	Saw whet Owl.	
2	Strix virginiana	Thomp	Great horned Owl.	
1	" aslo	Thomp	Screech Owl.	
2	" americana	Thomp	Barn Owl.	
2	" nyctea	Thomp	Snowy Owl.	
2	Syrnium nebulosum	Gray	Barred Owl.	
	ORDER 2. SCANSORES, CLIMBERS.			
2	Coccygus erythrophthalmus	Bon	Black billed Cuckoo.	
2	Picus villosus	Lin	Hairy Woodpecker. M. & F.	
2	" pubescens	Lin	Downy Woodpecker.	
2	Sphyrapicus varius	Baird	Yellow bellied Woodpecker. M. & F.	
4	Melanerpes erythrocephalus	Swain	Red headed Woodpecker. M. & F.	
1	Colaptes auratus	Swain	Golden winged Woodpecker.	
	ORDER 3. INSESSORES, PERCHERS.			
6	Trochilus	Lin	Hummingbird, M. & F.	
3	Chaetura pelasgia	Steph	Chimney Swift. M. & F.	
2	Antrostomus vociferus	Bon	Whippoorwill.	
2	Ceryle alcyon	Boie	Belted Kingfisher. Male.	
1	Sayornis fuscus	Baird	Pewee, or Phebe-bird.	
1	Empidonax minimus	Baird	Small Flycatcher.	
2	Turdus pallasii	Cab	Hermit Thrush. M. & F.	
1	" fuscescens	Steph	Wilson's Thrush.	
2	" migratorius	Lin	Robin. M. & F.	
1	Gallinula galeata	Bon	Florida Gallinules.	
1	Sialia sialis	Baird	Blue Bird. Female.	
1	Parus atricapillus	Lin	Chickadee.	
2	Sitta carolinensis	Gmel	White bellied Nuthatch.	
2	Certhia americana	Bon	American Creeper.	
1	Parula americana	Bon	Blue yellow backed Warbler.	
1	Geothlypis trichas	Cab	Maryland Yellow Throat. M.	
1	Dendroica canadensis	Baird	Black throated Blue Warbler.	

No. of specimens.

ORDER 3—CONTINUED.

1..... " coronata.....Gray.....Yellow rumped Warbler. Male.
4..... " Blackburniae.....Baird.....Blackburnian Warbler. M.
2..... " striata.....Baird.....Black poll Warbler.
1.....Euthlypis canadensis .....Cab.....Canada fly-eating Warbler.
2.....Setophaga ruticilla .....Swain.....Redstart.
2.....Pyranga rubra .....Vieil.....Scarlet Tanager. M. & F.
2 .....Hirundo lunifrons.....Say.....Cliff Swallow.
1..... " bicolor.....Vieil.....White bellied Swallow.
3.....Progne subis.....Beard.....Purple Martin. M. & F.
2.....Ampelis cedrorum.....Beard.....Cedar Bird.
1.....Collyrio borealis .....Beard.....Northern Shrike.
1.....Vireo gilvus.....Bon.....Warbling Vireo.
1.....Pinicola canadensis .....Cab.....Pine Grosbeak.
1.....Carpodacus purpureus.....Gray.....Purple Finch.
4.....Chrysomitris tristis.....Bon.....Yellow Bird. .
1..... " pinus .....Bon.....Pine Finch.
2.....Curvirostra americana.....Wil.....Red Crossbill. M. & F.
1..... " leucophrys.....Wil.....White winged Crossbill.
3.....Ægiothus linaria .....Cab.....Lesser Redpoll.
1.....Plectrophanes nivalis. .....Meyer.....Snow Bunting.
1.....Zonotrichia leucoprys.....Swain.....White crowned Sparrow.
1..... " albicollis.....Bon.....White throated Sparrow.
1.....Junco hyemalis,.....Scla.....Snow Bird.
1 .....Spizella socialis.....Bon.....Chipping Sparrow.
4.....Melospiza melodia .....Baird.....Song Sparrow.
2.....Guiraca ludoviciana .....Swain.....Rose breasted Grosbeak.
1.....Cyanospiza cyanea.....Baird.....Indigo Bird.
5.....Dolichonyx oryzivorus.....Swain.....Bobolink. M. & F.
5.....Agelaius phœniceus.....Vieil.....Red winged Blackbird.
2.....Sturnella magna .....Swain.....Meadow Lark.
2.....Icterus Baltimore.....Dan.....Baltimore Oriole. M. & F.
1.....Scolecophagus ferrugineus ....Swain.....Rusty Blackbird.
1.....Quiscalus purpureus.....Licht.....Purple Grakle.
2.....Corvus americanus.....Aud.....Crow.
5.....Cyanurus cristatus..... .....Swain.....Blue Jay. M. & F.
1.....Perisoreus canadensis.....Bon.....Canada Jay.
1.....Fringilla canariensis.....Vieill.....Canary Bird.

ORDER 4. RASORES, SCRATCHERS.

2.....Ectopistes migratoria .....Swain.....Wild Pigeon.
1.....Tetrao canadensis..... .....Lin.....Spruce Patridge.
2. ....Bonasa umbellus .....Steph.....Ruffed Grouse.

ORDER 5. GRALLATORES, WADERS.

1.....Botaurus lentiginosus.....Steph.....Bittern.
.....Butorides virescens,.....Bon.....Green Heron.

No. of Specimens.

ORDER 5—CONTINUED.

1.....Philohela minor.....Gray.....American Woodcock.
1.....Gallinago Wilsonii.....Bon.....Wilson's Snipe.
1.....Gambetta melanolenca.....Bon.....Teltale Tatler.
1.....Actiturus bartramius.....Bon.....Upland Plover.

ORDER 6. NATATORES, SWIMMERS.

2.....Bernicia canadensis.....Boie.....Canada Goose. M. & F.
1.....Anas obscura.....Gmelin.....Black Duck.
1.....Aix sponsa.....Boie.....Summer or Wood Duck.
1.....Anas albeola.....Thomp.....Dipper Duck. Female.
1..... " perspicillata.....Thomp.....Butter Bill Duck.
1.....Mergus americanus.....Cas.....Sheldrake.
1.....Larus marinus.....Lin.....Great Gull. Female.
1.....Chroicocephalus philadelphia...Law.....Bonaparte's Gull.
4.....Colymbus torquatus.....Brun.....Loon. M. & F.
1..... " septentrionalis.....Lin.....Red throated Diver.
1.....Podiceps griseigena.....Gray.....Red necked Grebe.

DOMESTIC FOWLS.

1.....Pavo cristatus.....Peacock. Male.
1.....Gallus.....Spanish Fighting Cock.
1.....Columba.....Dove.

There are also a few specimens of value belonging to the Thompson collection, but those are chiefly valuable, as being the specimens described in his work, as types of Vermont birds at that time. Their plumage is somewhat faded, and as they were intended for scientific use, instead of exhibition, they are not stuffed to nature, and are little better than bird skins. Their age prevents the possibility of putting them up in a manner for favorable exhibition, and for that reason most of them are of small value to the cabinet. As it is my intention to add types of all the species of Vermont birds, any birds killed in the State not on this list, if in good plumage, and not injured by shooting, I should be glad to receive, either by express or otherwise, for the cabinet. Such as we have on this list not being of as much value, I would request that the friends of this enterprise

would not forward them, unless in some way they were thought to be very fine specimens. The express bills on useless birds retard our work, as it is needless expense taken from a limited fund. I will further state, for the benefit of those interested, that birds to be of value as specimens must be in winter plumage as much as possible, and our migratory birds must be killed as soon as possible after their arrival, or just before their departure. Summer specimens are of no value whatever.

OOLOGY.

Our collection of birds' eggs is limited, and we desire for the present that all the friends of this collection would save us as many eggs as possible. If the eggs are found early it is but a minute's work to perforate the ends with a needle and blow out the contents; if incubation has progressed so far that the contents cannot be blown out, with a sharp pointed knife, or a thin fine file, a square can be cut out of the side, and the contents broken up and washed out. The piece of shell cut out can be put in place and held there with a drop of mucilage applied inside, so as to flow around the piece cut out; a drop of varnish is even better. The shell must be dry before the application of either.

CRANIOLOGY.

In this department I have added forty-five specimens. With the exception of Canis lupus, Lin., (common Wolf;) Felis concolor, (Catamount,) we have a complete set of the skulls of Vermont mammals. Any one sending us either of the skulls above mentioned will confer a great favor. As we have only a limited number of the skulls of birds, all will be acceptable for some years to come. To those not accustomed to cleansing bones I would say, that after boiling in clear water for a sufficient time to remove

the muscles, they may be set away for a few days to soak in a solution of sal soda and water, made by dissolving four ounces of salt to one gallon of thewater; then after boiling in the same until the bone seems to soften upon the outside, but not enough to destroy any portion of its surface, wash out and lay in the sun to bleach. For small skulls much less time is required.

ENTOMOLOGY.

I have collected several hundred insects, and have received a few from other parties by exchanges. A full set of entomological specimens representing Vermont species must be the work of years, and I would ask the co-operation of all within the State that are in any way interested in the work. Full directions for mounting specimens will be sent when wanted. To preserve such specimens from destructive insects, it becomes necessary to poison them. This can be best done by a solution of corrosive sublimate, which can be applied to their bodies with a camel's hair pencil. It is best to use it as strong as may be without whitening the insects, but if too much is added and the specimen whitened, it is not spoiled; as it may be dissolved away with alcohol and thus restored. Insects may be killed by the inhalation of chloroform if desired, but for beetles and many other small insects their immediate immersion in alcohol, in which they can be kept for years, is the most desirable method for collectors. By this method a wide mouthed bottle which contains strong alcohol, in which specimens can be put as soon as caught, is all that is necessary. After they become fully saturated they can be taken out of the alcohol and sent by mail in a small box without any injury. But as butterflies and moths cannot be thus preserved, pinning is sometimes necessary. Great care should be taken that spec-

imens pinned should be perfect, that their wings be fully extended and their antennæ and limbs not allowed to curl up as they are inclined to do, but dried in as natural a position as possible. Constant care must be taken after the specimen is put up to preserve it. Though poisoned, it is not free from the depredations of some destructive insects, and must be kept in a close box. Dust is also a great injury, as well as light, so it is necessary to protect very nicely from all injuries. The chrysalis and caterpillar should also be preserved; the latter can usually be preserved in alcohol.

CONCHOLOGY.

An inland state like Vermont would seem a poor place for a local collection of shells, but it is by no means as deficient as it seems. I have been able already to collect many species, and many more can be collected. To those interested, I would say that I should like to have them collect in their localities ten shells of a kind, if possible, if not, as many as may be, marking distinctly where found. If they will send such collections to me for the use of the cabinet, I will return them named samples of their collection, and, as soon as may be, place the others in the cabinet, and to their credit if they wish, paying them in exchanges as soon as our collection is large enough to supply them. I should be glad to impress upon the public mind the great scientific value of such a local collection, and attract their attention to such an extent that persons finding shells in Vermont would save them and forward by their town representative to our cabinet.

MINERALOGY.

In this department, as no geological survey is in progress, and no authorized expense could be incurred in the field, for the state no progress could really be made. I have, however,

added about two hundred specimens, many of them of interest, having comparative value, or new representations of Vermont minerals not previously in the cabinet; I have also re-arranged many specimens, preparing new labels, using new cases, and in every way trying to utilize the limited space allowed. It will become immediately necessary, if the specimens are all put on exhibition, to have more room. I trust such want will be considered by the next session of our legislature. In the meantime all collections made will be cared for and held in readiness for exhibition when space shall be given them. Let this fact deter no one from contributing thereto, as their contributions will be just as valuable and will at proper time be placed on exhibition in a favorable manner.

During the past year some mines in Vermont have been wrought with profit, and the marble interest was never larger or more profitable. At Gaysville, Saltery & Smith have inaugurated extensive gold washing, which they claim thus far profitable. As I have before expressed, it is still my opinion, if gold ever pays in Vermont it will be like this at Gaysville, from washing. Quartz mining in this section for gold has always been a failure; it is still my impression it ever will be. At the present high price of metals, if long continued, doubtless some mines in Vermont, now abandoned, might be wrought with profit, and perhaps some new veins now known may be opened, as well as other discoveries made. When metals are as now high priced, and in active demand, prospecting is usually prosecuted with more vigor and effect.

ACKNOWLEDGMENTS.

Our acknowledgments to gentlemen in the State and out, who have aided us in various ways, should be numerous, but

only a few names can be mentioned. I would, however, make particular mention of Prof. Peter Collier, of Burlington, Hon. Charles Reed, and T. C. Phinney, of Montpelier, Prof. J. A. Allen, of Cambridge, Mass., Philip S. Sprague, of Boston, Mass., and J. H. Huntington, of Hanover, N. H.

Our thanks in behalf of the State are especially due to the management of the "Boston, Concord & Montreal and White Mts. R. R.," "Conn. & Pass. Rivers & Massawippi Valley R. R.," "Vermont Central R. R. and its branches," "Concord Railroad and its branches," "Boston, Lowell & Nashua R. R. and branches," and "Eastern Railroad and branches," for free passes over their lines of road.

Hoping that the interest universally expressed in favor of our Vermont scientific collection may increase, rather than diminish, and that the ready assistance redered us in our endeavors to obtain specimens of interest for this collection may continue, and the results produced be worthy of our "Green Mountain State,"

I am respectfully yours,

HIRAM A. CUTTING,

State Geologist and Curator State Cabinet.

Lunenburgh, Vt., November 18, 1872.

REPORT

OF THE

GEOLOGIST AND CURATOR STATE CABINET

FOR 1874 AND 1875,

WITH

DIRECTIONS FOR COLLECTING SPECIMENS

AND AN

ADDRESS

ON

PARASITIC INSECTS OF DOMESTIC ANIMALS,

GIVEN

Before a meeting of the State Board of Agriculture, Manufactures and Mining, at Westminster.

BY HIRAM A. CUTTING, A. M., M. D.,
STATE GEOLOGIST AND CURATOR.

MONTPELIER:
FREEMAN STEAM PRINTING HOUSE AND BINDERY.
1875.

REPORT OF THE STATE GEOLOGIST.

To His Excellency ASAHEL PECK, *Governor of Vermont:*

SIR:—I have the honor to respectfully present the report of the management of my department for the years 1873 and 1874. I have had so many applications to examine mines, or localities where it was supposed minerals could be found, at the expense of the State, I deem it advisable to present Section 2, of Act No. 76, approved November 26, 1872, which is as follows:

"Sec. 2. It shall be the duty of the State Geologist to give counsel respecting the openings to be made in mines and quarries when desired by the owners thereof or any person interested therein, and to faithfully advise and assist all such persons as may employ him in any attempt to discover new mines and quarries, or to encourage the working of those already discovered: provided, however, that in no case and under no circumstances shall said geologist charge to or receive from the State anything for services or expenses except he is directly employed by the governor of the State, but shall look to his employers for any compensation that he may reasonably deserve to have for any professional services so by him rendered."

Agreeably to this act, I have replied to all letters, giving my opinion in regard to all specimens sent me, and fre-

quently their partial analysis, free of any charge whatever. In only few instances has anything further been required. I have also visited at my own expense several localities where I was led to believe valuable minerals might be found, as well as some localities not examined in our Geological Survey, and hold myself in readiness to make reports of such examinations when desired. I have received several letters from various parties thinking they had found coal, and I understand that one company have expended, or contracted to expend, one thousand dollars in boring for it. I take this opportunity to say, that all geologists agree, that no coal in workable quantity can be found in this State. The geological periods here represented are either too old or too recent to contain it. It is true that lignite has been found in small quantities, but can never be of much value. Some of the specimens sent me for coal have been plumbaginous slate, and others, varieties of manganese.

I have also received several specimens of plumbago. One from a limestone ledge in Swanton, sent by C. H. Fonda, would indicate that this vein might prove valuable. Specimens from Troy, Richmond, and other places, would show a possibility of workable veins.

I have received a large number of specimens of manganese from Topsham, most of which were rhodonite, but some were very good specimens of pyrolusite, and I intend, as soon as the snow permits, to examine the locality in question. As it is near the Montpelier and Wells River Railroad, it may be valuable.

I have partially examined extensive marl beds near the Portland and Ogdensburgh Railroad, in Danville and Peacham, and find them of great extent and of the best

material. I have no doubt but that marl can be taken from them with profit. Similar beds also occur near the Passumpsic Railroad in Sutton. I also examined a deposit of ochre on the farm of George Clarke, of that town. It is of superior quality, but hardly extensive enough to pay for working. I also saw deposits of ochreous earth in Lyndon and Newport.

Of the worth of the marble interests of the State, or of their inexhaustible quantity, too much cannot be said. A new quarry called the Central Vermont, at Pittsford, in abundance, variety and excellence, can hardly be surpassed. In Vermont is found, if we except a few localities on the southern extension of the Alleghany Mountain belt, nearly all of the first-class marble east of the Rocky Mountains, and almost every year develops extensive new quarries, not inferior to the old. Large amounts of capital can now find remunerative investment in opening new localities, or by increasing the work in quarries already opened.

The peculiar effects in glacial and drift actions have removed much of the loose and valueless stones, thus saving great expenditure, and giving sound marble at little depth.

As regards durability, our marbles challenge comparison with any others known. As building stone they prove unusually durable, and the great extent of this marble belt is beyond question.

PETRIFACTION.

For the past two years the newspapers of Vermont, as well as other States, have recorded several cases of supposed petrifaction of the human body, and as the belief that such may be the fact is so general, I have been requested to report upon such cases as I have examined. In the face of these

newspaper assertions, and also the affidavits of various reliable individuals, I must state that fact does not substantiate such reports. The petrifaction of any of the soft parts of a warm-blooded animal is as yet unknown to science. I have investigated seven cases of reported petrifaction of the human body, where the testimony in each case was more than sufficient to convict in any court at law. In one case the body was pounded with a shovel; in another several men witnessed the drilling of it for hooks; and in all the evidence was apparently as reliable as human testimony could be, but upon close re-examination, all proved to be remarkable cases of preservation, by a change of the soft parts of the body to adipocere; probably by their almost immediate immersion in water. Pretended petrifactions have been exhibited, but they were always statues cut from stone by some ingenious rogue that wished to humbug some one, and has been too often successful for a time, as with the Cardiff Giant, and so-called Indian boy, recently exhibited in several of the larger places of New England.

THE FROZEN WELL.

About a mile southwest of Brandon village there is a well nearly forty feet deep, the water of which has the peculiarity of freezing and remaining frozen, all the year. In 1858 the owner of the property began the usual excavations for water. After passing through soil and clay to the depth of fourteen feet, a bed of frozen gravel, some fifteen feet in thickness, was encountered. After passing the frost and digging some two or three feet, water was found. The excavation was then carried deep enough to furnish sufficient water, and stopped upon a clean pebbly bottom, into which an iron bar could be crowded down its length. In 1859 two other wells were

dug by the Boston Society of Natural History, seventy feet south, and also northwest, in one of which frost was found in different layers; the first being no more than two inches thick, while the last they did not pass through, but it must have been several feet.

There is also a similar frozen well in Owego, N. Y., and other places, both in this country and Europe.

These wells freeze over to great depth in the winter, and ice fills in much above the surface of the water, coating the stones upward, several feet, and they contain ice during all the summer months.

Various theories have been given to account for this phenomena, as by the sinking of cold air by its increased specific gravity, by Prof. Loomis; or the preservation of ice and frozen material since the drift period, many thousands of years ago, by Prof. E. Hitchcock; as well as the refrigerator opinion of A. D. Hager, all of which a few simple experiments seem to disprove. It is a well known fact that the natives of India have from ancient times produced ice in elongated wells or deep ditches, by means of evaporation; placing water in small shallow dishes with straw around them, more compact at the top, and then forcing a current of air through the straw, causing rapid evaporation and consequent freezing of the water in these pans. The freezing of water under the receiver of an air pump, by the evaporation of ether, is also a familiar experiment; and this principle is carried out in the hygrometer, where the increased cold by the evaporation of moisture from the wet bulb of a thermometer shows the amount of such evaporation, which often causes a difference of twelve degrees in temperature.

Believing that it was impossible that frost could have remained from the drift period, and that the specific gravity of cold air would be no greater in Brandon than elsewhere, and that all wells from that cause would be equally affected, and that the coating of the stones with ice above the water would indicate freezing from evaporation, I suggested that covering the well to prevent that continued exit of air heavily charged with moisture, should prevent freezing, and would do so to a great extent if the cold was caused by evaporation. Last winter it was covered, and no ice formed. One day in March, when it was not freezing cold, the cover was left open and ice formed in the well; but after closing it for a few days, it disappeared; though during the spring months ice could be formed by leaving the cover open. I think this solution to agree with philosophic facts, and that the peculiar, porous nature of the soil in which such wells are situated, would allow evaporation at great depths, which would cause a freezing current of air to pass underneath impervious strata, like clay beds, to find exit in porous places. This would be ample cause for frost as found. Other excavations have shown these clay beds in patches and not continuous, which would show the theory usstained by additional fact.

ADDITIONS TO THE CABINET.

By donations and otherwise several hundred specimens have been added to our geological and historical collection. Through the courtesy and liberality of our railroads such collections have been of but little expense to the State. I should be glad to specify, did space permit, the many favors received from individuals, as well as corporations; but feel-

ing that all of our contributors are friends to our cause, rather than egotists, I would present the thanks of all interested in science, and especially of those citizens of Vermont that are interested in our collection, to those that have so liberally helped us on our way, to make the Vermont State Cabinet of true value as a State collection.

ORNITHOLOGY.

The following new specimens of birds have been added:

No. of Specimens			
	ORDER 1. RAPTORES, ROBBERS.		
1	Aquila piscatrix	Vieillot	Fish catching Eagle.
2	Aquila chrysaetos	Wilson	The Golden Eagle.
1	Falco cooperu	Bonaparte	Cooper's Hawk.
2	Falco Buteoides	Nuttall	Red shouldered Hawk.
1	Falco Hudsonius,	Linn	Marsh Hawk.
2	Strix brachyotus	Linn	Short eared Owl.
2	Strix otus	Linn	Long eared Owl.
	ORDER 2. SCANSORES, CLIMBERS.		
1	Curculus, Americanus	Linn	Yellow Billed Cuckoo.
	ORDER 3. INSESSORES, PERCHERS.		
1	Caprimulgus vociferus	Wilson	Whippoorwill,
2	Caprimulgus americanus	Wilson	Night Hawk.
2	Muscapa crinita	Linn	Great crested Flycatcher.
1	Muscicapa flaviventris	Baird	Yellow billed Flycatcher.
1	Motacilla aurocapilla	Linn	Golden crowned Thrush.
1	Turdus rufus	Linn	Brown Thrush.
1	Motacilla calendula	Linn	Ruby crowned Kinglet.
1	Parus atricapillus	Linn	Crested Titmouse Chick-a-dee.
1	Sitta canadensis	Linn	Red bellied Nuthatch.
2	Motacilla varia	Linn	Black and White Creeper. M. and F.
1	Cistothorus stellaris	Cabanis.	Marsh Wren.
1	Sylvia domestica	Wilson	House Wren.
2	Sylvia ruficapilla	Wilson	Nashville Warbler.
2	Sylvia vireus	Wilson	Black throated Green Warbler.
2	Sylvia castanea	Wilson	Bay breasted Warbler.
1	Sylvia pinus	Wilson	Pine creeping Warbler.
2	Sylvia Pennsylvanica	Wilson	Chestnut sided Warbler.
1	Sylvia magnolia	Wilson	Black and Yellow Warbler.
1	Sylvia petechia	Wilson	Yellow Redpoll.
1	Sylvia minuta	Wilson.	Prairie Warbler.
2	Sylvia mitrata	Nuttall	Hooded Warbler. M. and F.

No. of Specimens.

ORDER 3—CONTINUED.

1.....Sylvia chrysoptera.....Wilson.....Golden winged Warbler.
1.....Pipra polyglotta.....Wilson.....Yellow breasted chat.
2.....Hirundo americana.....Wilson.....Barn Swallow.
2.....Muscicapa olivacea.....Linn.....Red eyed Vireo. M. and F.
1.....Muscicapa cantatrix.....Wilson.....White eyed Vireo.
1.....Alanda comuta.....Wilson.....Skylark. Shorelark.
1.....Alauda alpestris.....Wilson.....Brown Lark.
1.....Poocaetes.....Baird.....Buff breasted Finch.
2.....Fringilla tristis.....Linn.....Yellow Bird.
1.....Fringilla arborea.....Wilson.....Tree Sparrow.
1.....Fringilla pusilla.....Wilson.....Field Sparrow.
1.....Fringilla palustris.....Wilson.....Swamp Sparrow.
2.....Fringilla rufa.....Wilson.....Fox colored Sparrow.
2.....Fringilla pecoris.....Gmelin.....Cow Bunting.
2.....Fringilla canadensis.....Latham.....Tree Bunting.
3..... Icterus spurius.....Bonaparte.....Orchard Oriole,
1.....Corvus corax.....Wilson.....American Raven.

ORDER 5. GRALLATORES, WADERS.

1.....Ardea Herodias.....Linn.....Great Blue Heron or Crane.
1.....Botaurus lentiginosus....Stephens.....The Biteran Stakedriver.
1.....Buteoides virescens.....Bonaparte.....The Green Heron.
1.. ...Tringa macularia..... .....Linn.....Spotted Sandpiper.
2.....Rallus crepitans..... ...Gmelin.....Clapper Rail. M. and F.
1.....Rallus virginianus.....Linn.....Virginia Rail.

ORDER 6. NATATORES, SWIMMERS.

1 .....Graculus carbo.....Gray.....Cormorant.

We still desire specimens of rare birds killed in Vermont, and wish such when killed sent to us immediately by express As there is an appropriation to pay express charges, such charges need not be prepaid. Should it be the desire of parties donating the birds that their name should appear on the specimen, a letter stating that fact, with name and residence, must be sent by mail. If birds are caught in traps, do not send them alive, as their plumage will be spoiled, but kill by pouring a spoonful of chloroform down their

throats, and then wrap up in a paper before boxing, so as to retain their feathers in the most natural position.

OOLOGY.

We still desire many more birds' eggs. It is absolutely necessary for their preservation that the contents of the shell be removed. If incubation has progressed so it cannot be blown out in the usual way, the shell may be cut with a three-cornered file, and a piece taken out, and after the contents has been washed out and the shell dried, returned in place, and held there by a drop of mucilage.

I will exchange for egg shells, minerals, or other specimens, if desired.

CRANIOLOGY.

We now desire, to complete our set of Vermont mammals, the skull of the wolf, (canis lupus,) and catamount, (felis concolor). If any party will furnish them, we will make fair remuneration.

Thanks for skulls of birds received as donations, and more desired.

CONCHOLOGY.

I have already secured quite a collection of Vermont shells. E. M. Goodwin, Esq., of Hartland, has furnished more than any other individual. We trust the friends of this speciality will not forget that they can send them nicely through the mail, and that we will exchange, giving specimens from other localities, as soon as we can get them named and in order for distribution.

ENTOMOLOGY.

As we now have a fine case for our entomological specimens, we hope our collection may increase rapidly; and that

all friendly to the enterprise may collect understandingly, we compile a few notes from Packard, Dimmock, and our experience, for guidance.

At no time of the year need the entomologist rest from his labors. In the winter under the bark of trees, and in moss, he can find many species, or detect their eggs on trees, etc., which he can mark for observation in the spring when they hatch out. He need not relax his labors day or night. Mothing is night employment. Skunks and toads entomologize at night. Early in the morning, when the dew is still on the leaves, insects are sluggish and easily taken with the hand; so at dusk, when many species are found flying; and in the night, the collector will be rewarded with many rarities, some species flying then that hide themselves by day, while many caterpillars leave their retreats to come out and feed, when the lantern can be used with success in searching for them.

A net is indispensable to the collector, and may be simply made by making a loop of strong iron or brass wire, of about three sixteenths of an inch in thickness, so that the diameter of the loop or circle will not exceed twelve inches, leaving an inch to an inch and a half of wire at each end bent at nearly right angles. Bind the two extremities of the wire together with smaller wire, and tin them by applying a drop of muriate of zinc, then holding it in the fire or over a gas flame until nearly red hot, when a few grains of block tin or soft solder placed upon them will flow evenly over the whole surface, and join them firmly together. Take a Maynard rifle cartridge tube, or other brass tube of similar dimensions; if the former, file off the closed end or perforate it for the admission of the wire, and having tinned it in the same manner on the inside, push a tight-fitting cork half

way through, and pour into it melted tin or soft solder, and insert the wires: if carefully done, you will have a firmly constructed and very durable foundation for a collecting net. The cork being extracted will leave a convenient socket for inserting a stick or walking cane to serve as a handle.

Various kinds of forceps are used for handling insects, but practice will make any kind answer, even a home devised pair made of a strip of sheet iron bent in the shape of spring forceps will work very well.

KILLING INSECTS FOR THE CABINET.

Care in killing affects very sensibly the looks of the cabinet. If hastily killed and distorted by being pinched, with the scales rubbed off and otherwise mangled, the value of such a specimen is diminished either for study or the neat appearance of the collection.

Besides the vapor of ether, chloroform, and benzine, the fumes of sulphur readily kill insects. Large specimens may be killed by inserting a pin dipped in a strong solution of oxalic acid. An excellent collecting bottle is made by putting into a wide-mouthed bottle two or three small pieces of cyanide of potassium, which may be covered with cotton, about half filling the bottle. The cotton may be covered with paper lightly attached to the glass, and pierced with pin-holes; this keeps the insects from being lost in the bottles. For Diptera, Loew recommends moistening the bottom of the collecting box with creosote. This is excellent for small flies and moths, as the mouth of the bottle can be placed over the insect while at rest; the insect flies up into the bottle and is immediately suffocated. A bottle well prepared will last several months, even a year, and is

vastly superior to the old means of using ether, or chloroform. The inconvenience of taking small insects from a net is well known, as the most valuable ones usually escape; but by placing the end of the net, filled with insects, in a wide-mouthed bottle, and putting in the cork for a few minutes, they will be suffocated.

PINNING INSECTS.

The pin should be inserted through the thorax of most insects. The coleoptera, however, should be pinned through the right wing cover.

The specimens should all be pinned at an equal height, so that about one fourth of the pin will project above the insect,—butterflies with their wings spread.

Large-mouthed bottles and tubes are indispensable for preserving specimens, and while collecting, almost all kinds of beetles can be advantageously thrown into alcohol, thus taking up but little space. Afterwards they can be pinned at leisure, or kept for exchange with other collectors. Care should be taken to have the alcohol sufficiently strong when the specimens are to be kept for a long time in it. Whenever it is necessary to preserve specimens from different localities, in the same bottle, and be able to distinguish them, they can be rolled up in thin, tough paper, on which may be written, with a sharp pencil, whatever notes are necessary.

Specimens can be sent by mail in small glass bottles of alcohol enclosed in wooden or tin boxes, with cotton or felt about them. They can also be sent in tin boxes, by packing them with cotton, soft paper or cloth, and then pouring just enough alcohol over them to saturate them.

Insects may be found in all localities, but to give the inexperienced collector a better chance of success, I add a list of

names and localities which will often enable him to find what he desires, and also serve as a partial guide in their classification.

LIST OF HABITATS.

CICINDELIDAE. CARABIDAE.

These are all predaceous, and are found in various places and at all seasons.

DYTISCIDAE. HYDROPHILIDAE. GYRINIDAE.

Feed upon carrion and insects about the water.

SILPHIDAE.

Feed upon carrion.

STAPHYLINIDAE.

These are found chiefly upon decaying animals and vegetables, and about excrement. They are supposed to devour the larvae of other insects.

HISTERIDAE. NITIDULIDAE.

Upon decaying animal and vegetable matter.

Lobiopa undulata.

Have been found under oak bark.

Amphotis ulkei. Phenolia grossa.

Found under butternut bark.

Ips sanguinolentus. Omosita colon.

Common about maple and birch sap, running from stumps.

Thymalus fulgidus.

The larvae feed upon a fungus, *(Polyporus betulinus,)* which is parasitic upon the trunks of white birch trees.

Catogenus rufus.

Under walnut and ash bark, early in the spring.

Cucujus clavipes.

Under butternut bark.

Brontes dubius.

Under chestnut bark.

DERMESTIDAE. BYRRHIDAE.

Among the species of these, are the notorious museum pests, which devour the specimens in our museums of natural history. They are not particular about their food, and take either animal or vegetable matter.

Lucanusdama.

Larvae live in decaying oak wood and bark, about which the beetles may be found.

Ceruchus piceus.

The larvae live in decayed chestnut and willow.

Passalus cornutus.

In several kinds of decayed wood.

CANTHON. COPRIS. PHANAEUS. ONTHOPHAGUS. APHODIUS. GEOTRUPES.

All the species of these genera feed upon excrement, and among them are the so-called tumble-bugs.

TROX.

Especially common about the hoofs and hair of decaying animals, and the refuse of tanneries.

Dichelonycha elongatula.

Upon chestnut and other leaves.

Serica trociformis.

Eats maple and oak leaves.

Macrodactylus subspinosus.

On many kinds of leaves, but very common on those of the grape and rose.

Anomala lucicola. Pelidnota punctata.

Common on grape leaves.

Cotalpa lanigera.

The larvae feed upon roots; the perfect insect on willow leaves.

Coraebus cogitans.

About alder.

Brachys terminans.

On oak leaves.

Alaus oculatus *and* myops.

In pine stumps and wood.

Melanotus fissilis *and* communis.

In decaying pine and other wood.

CLERUS.

Several species are found about fresh cut pine wood during the warmest days in spring.

CORYNETES.

Often common about carrion.

TENEBRIONIDAE.

These are usually found under bark and about fungus.

Tenebrio molitor.

This is the notorious meal beetle of Europe, and is very common n most granaries.

Boletotherus cornutus.

Found upon fungus growing on decayed wood.

Hopliocephala bicornis.

On many species of fungus.

Hypophloeus parallelus.

Under pine bark.

Cistela sericea.

Common upon flowers of many kinds, especially those of the meadow-sweet or tea-weed. *(Spiraea.)*

Rhipiphorus pectinatus.

Upon flowers of mountain-mint. *(Pycnanthemum.)*

Meloe angusticollis. Epicauta vittata *and* cinerea.

These usually feed upon the leaves of the potato.

Epicauta pensylvanica.

Upon the flowers of the golden-rod. *(Solidago.)*

Macrobasis fabricii.

Feeds upon the wild indigo. *(Baptisia tinctoria.)*

Mycterus Scaber.

Common on tea-weed blossoms.

Boros unicolor.

This species is found under the bark of dead yellow pine, where the bark is exceedingly loose.

Hylurgus terebrans.

Found about pine wood, in which the larvae feed.

Cossonus platalea.

Found under chestnut and butternut bark.

Conotrachelus nenuphar.

This is the notorious plum weevil or curculio.

Cryptorhynchus foveolatus.

Found upon the evening primrose. *(Œnothera biennis.)*

Pissodes strobi. Hylobius pales.

Common about pine.

Lixus concavus.

Feeds upon yellow dock.

Lepyrus geminatus.

This species is found on the willow.

Arrhenodes septentrionis.

Under the bark of dead oak trees.

Rhynchites bicolor.

Infests rose bushes, both wild and cultivated.

Attelabus rhois.

This species rolls the leaves of the hazel.

Cratoparis lunatus.

Often found upon a species of fungus growing on dead trees and stumps.

Bruchus pisi.

This is the common pea weevil.

Parandra brunnea.

Found in dead beech trees.

Orthosoma cylindricum.

The larvae live in pine wood.

Elaphidion villosum. Phymatodes variabilis.

The larvae feed upon oak wood.

Eriphus suturalis.

Found upon daisy blossoms.

Clytus robiniae.

The larvae feed upon locust wood. The beetles are often common upon yellow-weed blossoms.

Tetraopes tornator *and* canteriator.

Common upon milk-weed. (*Asclepias.*)

Saperda candida.

The larvae bore the wood of apple trees.

Desmocerus cyaneus.

Found upon elder blossoms.

Rhagium lineatum.

Common under pine bark in the early spring.

Strangalia. Leptura.

The species of these genera live about many different kinds of flowers.

Lema trilineata.

Very common on the potato.

Uroplata quadrata.

The larvae mine in apple leaves. The beetles can be found on the alder and the shad-bush. (*Amelanchier canadensis.*)

Cephaloleia metallica.

Found on the potato.

Chelymorpha cribraria.

Common on the wild morning glory.

Deloyala clavata.

Feeds upon the potato.

Coptocycla sexpunctata.

Very common on the wild morning glory.

Galeruca tomentosa.

Upon the golden rod.

Galeruca sagittariae.

Common upon a water weed, the arrow-head. *(Sagittaria.)*

Diabrotica vittata.

Very destructive to cucumber vines.

Diabrotica 12-punctata.

This species is found on the golden rod.

Disonycha alternata.

Common on the willow.

Blepharida rhois.

Feeds upon the blossoms and leaves of sumach.

Labidomera trimaculata.

Upon milk-weed. *(Asclepias.)*

Calligrapha scalaris.

Found on the elm.

Calligrapha spiraeae.

Feeds upon the leaves of the hazel.

Calligrapha philadelphica.

Feeds upon the leaves of osier.

Calligrapha bigsbyana.

Upon willow leaves.

Gastrophysa caeruleipennis.

Feeds upon the leaves of knotgrass. (*Polygonum aviculare.*).

Gastrophysa vitellinae.

This species is common on the willow.

Eumolpus auratus.

Very common on the dogbane. (*Apocynum cannabinum.*)

Heteraspis pubescens.

Very common on the scabish.

Chlamys plicata.

On the sweet fern. (*Comptonia asplenifolia.*)

COCCINELLIDAE.

All the species of these are supposed to feed upon other insects and their eggs, with the exception of *Epilachna borealis*, which is said to devour the leaves of the pumpkin. The *Coccinellidae* are often called lady bugs, or lady birds.

Lycoperdina lineata.

These are often very common under boards and stumps during the middle of the winter. I have never found them except in cold weather.

When specimens are sent to me with the request that I tell something of their habits or history, they will receive attention, and the reply returned as soon as possible, and without charge.

MISCELLANEOUS.

About three years ago a moose (Alce Americanus), after passing through the north part of the State, was killed in New Hampshire; his horns may be found in the Cabinet, which are large but "in the velvet," as hunters say, as the last relic of an animal that has left little more than his bones to attest his previous existence in the State. The skull with short horns is the skull of the last moose killed within our bor-

ders, being killed with an engine on the Grand Trunk Railroad, near Island Pond, about fourteen years since.

RELIC FOUND.

Some twenty years ago, while a party were at work repairing the Central Vermont Railroad at Swanton, one of the workmen discovered a peculiar, white-looking stone, as he supposed, in the bank. He struck it with his shovel and picked it up. Its heft still further attracted his attention; and he threw it up to the overseer for his examination. The overseer found it to be a chunk of lead, much corroded, and covered with spruce gum upon the ends; this he removed with his knife and found the lead hollow, in the interior of which he found a paper, rough and old, but written over on one side with words which he could not fully make out, but which were afterwards read, and a fac simile made of the writing, a copy of which is now in the State Cabinet, where the original was placed by Dr. Hall of Swanton, subject to his control, and was by him taken and the fac simile left in its place, in 1873. I understood from him that the owner is a lady in Burlington, and it is to be hoped that she will donate the same to the State Collection. The written manuscript, being in ancient English, reads as follows:

Nov. 29, A. D. 1564.

This is the solemn day. I must now die. This is the 90th day since we left the ship; all have perished, and on the banks of this river I die. So farewell. May future posterity know our end.

JOHN GRAYE.

Many suppose this the trick of some insane person or rogue, and that it ought not to receive credence; but the arguments in its favor are, to many minds, conclusive as to

its antiquity. It is deemed certain that it was honestly found as above stated, and also found several feet from the surface. Its exact history can probably never be known.

THE AX MARK.

In January, 1872, Hosea Garfield cut a hemlock tree about two and a half feet in diameter, on his place a mile north of the village in Sheffield. It grew on the highland, and was apparently sound, though somewhat shaky, as is usual for hemlocks to be. When the tree fell, about eighteen inches of the heart pulled out and remained hanging on the stump, revealing ax marks at the upper end. Thledis Mr. Garfield to investigate, and he cut out the mark. It seems that when the tree was about four inches in diameter it was cut more than half down with a sharp ax. This came near destroying the life of the tree, and the growth is marked by a hard, knurly growth rather than by regular grains, until this mark was nearly healed; outside of this growth there were counted distinctly two hundred and fifty-six grains. It seems probable that the mark was made two hundred and seventy-five years ago, at least. This is earlier than it is supposed that men with steel axes traveled in Vermont, yet of course some ship's crew might have touched upon the coast or been shipwrecked here, so as to give the possession of an ax to the Indian. Be it as it may, it is an interesting item in the ancient history of Vermont. This ax mark may be seen in the State Cabinet.

Should other relics of ancient date be found, we trust the friends of history will place them here also, that they may be preserved.

Noticing with pleasure the increasing interest in this

department of Natural History, and hoping that our future endeavors to procure specimens of value may, through its friends, be crowned with success,

I am respectfully yours,

HIRAM A. CUTTING,

State Geologist and Curator of State Cabinet.

Lunenburgh, Vt., November 25, 1874.

PARASITIC INSECTS.

AN ADDRESS GIVEN BEFORE A MEETING OF THE STATE BOARD OF AGRICULTURE, MANUFACTURES AND MINING, AT WESTMINSTER.

Our subject of "Parasitic Insects," though perhaps not as pleasant as many others, certainly demands the attention of all agriculturists. They are in reality a pest that should be guarded against, and though common practices may prevent fatal effects, it is in my opinion necessary that the best methods in all instances should be known, both to prevent and exterminate them. The facts I present are such as I have been able to glean from observation and study, and although my views may in some points need modification, I trust that in the main they are correct. Where my own observations are imperfect, I have adopted the opinions of the best observers and authors known to me; and I am in such cases indebted to their labors for statements perhaps more valid than my own.

Parasitic insects infesting farm stock are numerous, and many times very injurious to the health of the animal in which or on which they live. But I can at this time speak of only the best known and most injurious species, hoping that by so doing I may incite some one to become a student of natural history, pursuing closely his observations on these domestic parasites, if I may so call them; and

thus not only add to our scientific knowledge, but greatly benefit himself and the community at large.

LICE.

Perhaps more common than any other parasite is that small, wingless, and disgusting insect thrust upon Egypt as one of the great plagues of God to a disobedient people: and which is today everywhere notorious. There are several species of lice, or as naturalists call them, *Pediculi*, which are found upon cattle.

The most common is *Homatopinus vitali*, which is of a palish brown color, sometimes slightly spotted with black, having two radiant black eyes, and with one of the most peculiar mouths that insects have; when at rest its mouth forms a protuberance on the front of its head but contains a sucker which is forced out at will; when extended it terminates in several little pointed hooks which aid it first in inserting its sucking tube, and then by turning outwards, hold it with a tenacious grip in the skin of its victim. Its abdomen is composed of rings or bands which extend round the insect. They have six legs, each terminating in a strong nail that folds back into a groove, thus forming a pincer that enables the louse to cling to the hair with great tenacity.

Their reproduction from nits is well known. The female glues its egg to the hair, at the time of its deposit, by a fluid that almost instantly hardens, fixing the egg or nit so firmly that the strength of the hair will hardly admit of its removal. From four to ten days are required for the hatching, according to the warmth of the weather, and ten days more for them to come to full maturity; and yet their

fecundity is so great that it has been estimated that a single pair in sixty days will literally cover a young creature with those vermin. When stock is found to be so infested, at once comes up the question of a remedy. Soap suds, oil, tobacco, kerosene, ashes, mercurial ointment, benzine, turpentine, brine, and even alcohol, are recommended, and many times the creature has suffered much more from the remedy than the louse. Every one can see that oil (whale or lard oil) would be the most harmless remedy, and at the same time it is the most effectual. The louse, like the animal on which it dwells, must breathe, but it breathes in a very different manner, drawing its breath through spiracles on its sides. The air penetrates small tubes, called trachea. The oil at once stops those tubes, and as the louse cannot breathe, it dies of suffocation. This is a sure but perfectly harmless remedy. It need not be applied in great abundance, but if whale oil is used, a little applied the whole length of the back will be effectual, and at the same time it helps allay the inflammatory action produced by the constant biting of the lice. Lard rubbed in the hair is equally effectual; and I would here state as my opinion that the use of the other remedies named is even more dangerous to the health and growth of the animal than the lice themselves. Though there are several varieties of lice, oil is equally effectual in all cases, the larger varieties requiring more of it perhaps than smaller species.

TICKS.

We will next look after the diptera or fly tribe, so called, yet the first specimen we will consider infesting sheep as a tick, *Melophagus ovis*, is not a fly at all, but is assigned to that class from a singular conformation, as the bed bug

is to the tribe of winged bugs, though neither ever have wings. There are, however, ticks infesting birds, which have small wings that enable them to fly short distances. The fore part of the body of the sheep tick is small, the thick, roundish abdomen, however, is proportionally very large, generally in circumference about the size of a middling-sized pea. Its color, in its younger days, is pale red, the abdomen lighter, with an irregular white line on each side, and a red spot upon its back; with age comes a darker hue. They are extremely common in pasture grounds in early summer, and it is in such pastures that sheep become infected.

The sheep tick lays but one egg, and that is not in reality an egg, but a full grown pupa, which is fastened to the wool of the sheep, being at first white, then brown, from which the perfect tick escapes. The pupa is nearly as large as the whole insect at the time it is deposited, and does not grow until the perfect tick comes forth. It is furnished with a sucker of considerable length, yet it is so greedy in sucking blood that it will almost bury its head in the skin of the sheep or lamb on which it lives. They are a great pest, as they not only suck blood, but their bite is poisonous to a certain extent, as bunches can be felt around their bites. This inflammation and pain aids in the discomfiture, and sheep infested never do well

Various methods are recommended for their extermination, but it seems that a decoction of tobacco is the most practical and successful method. After the sheep are sheared in the spring, most of the ticks left will take refuge on the lambs, as their wool is then longer than that of their parents. It is at this time that their destruction should be brought about by dipping the lambs. Two

pounds of tobacco steeped in ten gallons of water is, perhaps, the best proportion. The farmer should not buy the poor, cheap, tobacco, which is a worthless preparation, made to satisfy some one's appetite for copperas, but good tobacco leaf. If he wishes other leaves and dirt with it, he can add them afterwards. When this wash is properly prepared, the lambs can be taken by their feet and dipped, without trouble or danger. It is, however, necessary that some one should keep their head out of the liquid, as it frequently injures them if allowed to run into their ears.

In England, and in fine throughout Europe, they mostly dip in the following preparation: A pound of arsenic is boiled with a pound of soft soap and a pound of purified potash in four gallons of water. The arsenic will be perfectly dissolved with the other ingredients. To this is added forty gallons of water, and the sheep dipped therein, the same as in the tobacco decoction spoken of. It is said that the arsenic has no injurious effect, and that it also protects from the bot fly. I have never known it tried in this section.

BOTS.

The next of the dipterous insects to which I call your attention are the flies whose larvæ are known by the name of bots, and a general description will, I think, suffice for the whole. The perfect insect is perhaps a little larger than the common meat fly; they resemble them somewhat in form, are very hairy, and have those hairs colored in rings, like bumble bees. Different species vary somewhat in their markings. Their life is very short, seldom exceeding twelve hours. They are never known to eat, and the whole aim and object of their

existence seem to be to deposit their eggs. They are known as bot flies, breeze flies, gad flies, &c., and their larvæ are called bots in horses, maggots in the heads of sheep, and wornils in the backs of cattle. There is another fly in this section, the *tabani*, also known as the gad fly, that bites horses and cattle, sucking their blood, and from this cause cattle and sometimes horses seem alarmed at the species which only hover around them to deposit their eggs, though they are really incapable of biting or stinging in any manner.

The sheep bot fly, *Œstrus ovis*, which is found all over the Northern States, has a wonderful history. They are of a general ash color, spotted with black, with darker bands than some other flies of this class. They appear during the whole summer; their eggs are laid in the nostrils of sheep, from one to seven or eight in each individual; those eggs almost immediately hatch, and their larvæ enter the frontal and maxillary sinuses and even the horns and brain, feeding upon the secretions produced by their presence. They attach themselves firmly by means of their tentaculæ or hooks, and it is almost impossible to dislodge them. They sometimes penetrate the brain, and produce death; and always doubtless produce much pain and bad feeling about the head of the sheep. When the larvæ are young, they are perfectly white and transparent, except two small, black, horny plates. As they increase in size, the upper surface becomes marked with two transverse brown lines on each segment, the anterior being shorter and narrower than the posterior, and some spots are also observable on their sides. The body consists of twelve segments beside the head. These larvæ move with considerable activity, holding with their tentaculæ to a fixed

point, and drawing up their body. When full grown they are about one inch long, and of a brownish white color. They then leave the nostrils of the sheep and fall to the ground, where on the earth or adhering to the side of a blade of grass, they in the course of a couple of days change to the pupa state in which they remain for about two months, when the chrysalis opens and the fly makes its appearance.

Every sheep-owner knows what a commotion the appearance of these flies causes among his flock. When a fly touches their nostrils they shake their heads, strike violently with their fore feet, hold their noses closely to the ground, and often run back and forth over the pasture, looking behind them now and then to see if their tormentors are coming, thus endeavoring to rid themselves of the fly which is trying to deposit its eggs in their nostrils. They will often thrust their noses into the dry dirt or soil, to prevent the insect from effecting a lodgment. It is from this habit, or fact, that some sheep owners plow a few furrows in their sheep pastures, thus furnishing the sheep an opportunity to protect themselves. They will sometimes assemble together, pushing their nostrils into each others' wool, or very near the ground, and stand for a long time, even in sultry weather. In this way only those upon the outside are exposed. The amount of injury caused by this parasite is in proportion to their number. If but few are present in each sheep their effects are hardly apparent, but if in large numbers, as is often the case, they are very injurious, sometimes causing the death of great numbers of sheep. The disease is frequently called "blind staggers."

There is no remedy, to my knowledge, that is entirely

effectual in stopping the ravages of this parasite, but yet almost all extensive sheep raisers have something that they rely upon. Whatever will keep the fly from depositing its eggs will of course prove effectual. That it might be possible to dislodge them, when small, by means of lime, pepper or snuff, or any other substance to produce sneezing, is quite probable, but after they are firmly attached, I do not believe they can be successfully combated. What in some cases proves effective, in others will be of no use. I think the one admitted to be the best, and certainly the one that looks to me most reasonable, is to smear the sheep's nose with tar. If done often, I believe this to be effectual. It is not disagreeable to the sheep, and I think many times it seems even agreeable. Do not smear their faces up to their eyes, as I saw a flock last summer, but in the vicinity of their nose, as near to their nostrils as possible. I have known some sheep raisers to bore large holes in a log which they filled with salt, smearing the top of the hole with tar now and then. In this way the sheep would keep their noses well covered with tar in their endeavors to get salt. The salt is also considered as an aid in prevention. It has recently been stated that a feather wet in a solution of carbolic acid and run up the nose of the sheep would dislodge the maggots, but I have never known it tried. The carbolic acid, of necessity, must be a very weak solution, else it would injure the sheep, and I therefore have great doubts of its success.

Another variety of bot fly, *Œstrus bovis*, having a very hairy body, with a large head, yellowish face, brown eyes, and black antennæ, with wings of smoky brown, lays its eggs on the backs of cattle, mostly on younger ones. They seem apprehensive of trouble when the fly approaches,

and if possible will get into water, and as it is one of the peculiarities of this fly never to fly over water, the creatures are there perfectly protected. Where those flies are abundant, as in some parts of Europe, the cattle will be perfectly furious, running or gadding away, as they call it, which peculiar actions of the cattle led people to call it the "gad fly."

In this country, the fly or perfect insect appears during the summer season, from June to September, and the females, after pairing, lay their eggs in the hair, near the skin, on the backs of the cattle. The eggs soon produce larvæ which eat their way into the skin of the animal and quite through into its flesh, where they remain during the winter.

After entering in this manner they gradually increase in size, in their burrows, eating, and in fact, living upon the pus formed by the inflammation their presence excites. In this way they produce abscesses under the skin, their burrows running directly downward with the posterior portion of the body, in which their breathing spiracles are situated near the opening, so as to obtain the necessary amount of air. The mouth is situated at the lower end of the insect, and is furnished with minute suckers, by means of which it sucks in the food upon which it lives, and with which it is surrounded.

It is when nearly full grown in the spring of the year that they are most commonly noticed. At this time they can easily be removed by squeezing the flesh surrounding them. They will be found more frequently upon yearlings than upon any other cattle. Their color when young is nearly white, but darker as they advance in age. When full grown, which is late in the spring, they work them-

selves out of their burrows backward, enlarging the hole little by little every day until they get out, when they fall to the ground, and change in a day or two to the pupa state, their dried up skin forming a black cover, or pupa case. In this case, imbedded slightly in the earth, they remain in the dormant state from six to ten weeks, when the top of the case comes off and a full grown perfect fly comes forth, ready to deposit its eggs as before stated. Farmers generally think that this bot is no real injury, and do not much regard it, but it is quite otherwise.

The presence of a few larvæ will do little or no harm, but many times the creatures suffer to such an extent that they will become poor, lose their appetite, and finally die. The skin will be removed, hundreds of holes upon the back will show what is beneath, yet the farmer will remark: "It is always so," and believe some other disease caused the creature's death, overlooking the real cause. Some kill the maggot, or wornil, by inserting a hot wire, but they can be as quickly squeezed out and much more safely, or their deposit can be prevented by tobacco wash, or any pungent smelling powder. In fact, it is stated that a little brushing, even once in two or three days, while the flies are about, will fully prevent the trouble.

Another fly of this species, *Œstrus gasterophilus equi*, has a large head, light yellow face and legs, antennæ rust colored, abdomen of a reddish yellow with black spots, its wings whitish, having a golden tint. It deposits its eggs upon the hair of the horse, and they are productive of the bots in horses, but it is hardly yet settled whether it is of any disadvantage to the horse. There are many books however that consider the bots in horses a grave affair, often producing sickness and death, yet it seems that

scientific examination has shown a few facts, viz: that the bot never gnaws or eats the horse's stomach until after the horse is dead. That it subsists upon the juices of the stomach alone, and though a large number might cause indigestion, to a certain extent, as a general thing it is more nearly harmless than any other parasite. Mr. Bracy Clark, whose careful and laborious investigations entitle his opinion to great respect, believes the effect of bots to be healthy rather than otherwise.

The female fly, in approaching the horse for the purpose of laying its eggs, carries her body nearly upright in the air, the protruded ovipositor, or egg-tube, being curved inward and upward. Suspending herself for a few seconds before the part of the horse on which she intends to deposit the egg, she suddenly darts upon it and leaves the egg adhering to the hair; she hardly appears to settle, but merely touches the hair with the egg held out on the extreme point of the ovipositor, the egg adhering by means of a glutinous liquor with which it is covered. She then leaves the horse at a small distance, prepares a second egg and poising herself before the part, deposits it in the same way. The liquor dries, and the egg becomes firmly glued to the hair. This is repeated until four or five hundred eggs are sometimes placed on one horse. The skin of the horse is usually thrown into a tremulous motion on the touch of the insect, which merely arises from the very great irritability of the skin and cutaneous muscles at this season of the year, occasioned by the heat and continual teasing of the flies, till at length these muscles appear to act involuntarily on the slightest touch of any body whatever. The fly does not deposit its eggs at random on the horse's body, but selects those parts which are most likely to be nibbled by the horse. The

inside of the knee is frequently chosen. But all farmers must have noticed how commonly the eggs of the bot are deposited on that part of a horse's shoulder which he can never reach with his mouth, and thus, to a casual observer, it would seem that they must perish and fail in the object for which their parent designed them. Now there is a provision of nature that exactly counteracts this difficulty.

When horses are together in a pasture, and one of them feels an irritation on any part of the neck or shoulder which he cannot reach with his mouth, he will nibble another horse in the corresponding part of his neck or shoulder, and the horse so nibbled, will immediately perform the kind office required, and begin nibbling away in the place indicated. Horses when they become used to this fly and find it does them no injury, by stinging or sucking their blood, hardly regard it, and do not appear to be aware of its object. When the eggs have remained on the hairs four or five days, they become mature, after which time the slightest application of warmth and moisture is sufficient to bring forth in an instant the latent larvæ. At this time if the lips or the tongue of the horse touch the egg, its shell is thrown open and the young larva liberated. This readily adheres to the moist surface of the tongue, and is from thence conveyed with the food to the stomach. The biting of other flies frequently aid the propagation of the bot by causing the horse to nibble the irritation they have caused. There is hardly one larva in fifty that arrives safe in the stomach of a horse, and yet if we were to open a horse the stomach would often be found literally full of them. They are of a reddish yellow, and each of their segments is armed

at the posterior edge with a double row of triangular spines, large and small alternately, yellow at the base and black at the point, which is always turned backwards.

The head is furnished with two hooks which serve to fasten the larvæ to the interior coots of the stomach. The spines with which the whole body is furnished contribute to fix it more solidly, preventing the creatures from being carried away by the food as it goes through the process of digestion.

These larvæ are nourished by the mucus secreted by the stomach, and doubtless breathe the air swallowed by the horse with its food, having the power of suspending its respiration, like a frog, at its pleasure. It must be acknowledged, however, that it must have a gaseous atmosphere, as many gases are generated in the stomach of the horse.

Arrived at a state of complete development, the larva lets go its hold and is carried with the food through the intestinal canal, leaves it by the anal orifice, and on touching the ground at once begins to go through its metamorphoses. The skin then thickens, hardens and becomes black. All the organs of the animal are composed of a whitish pulp which soon assumes its destined form, and the insect becomes perfect. It then lifts a lid at the anterior part of its cocoon, emerges, dries its wings, and flies away.

As it may reasonably be supposed that bots are injurious, to some extent, in the horse; in fine, that a horse cannot be healthy when its stomach, as some express it, is "full of them," it would be well to make use of a simple and effectual preventive, that is, to remove or destroy the eggs. Many drugs are recommended and in use to

expel or kill them, but you may rest assured anything that will injure them will be quite as likely to injure the horse.

There is also the *Gastrophilus hemorrhoidalis*, or red-tailed bot fly, which is a much smaller species than the above, and much less common. This fly is of a grayish black color, with a bright orange red tipped abdomen, which gives it its specific name. The larvæ have the same general habits and are found in the same situations as the common bot, but they are smaller and whiter. The pupæ are deep red and change from the larva in two days after leaving the horse. In about two months the fly emerges from the pupa case and deposits its eggs. The period of time during which this fly is found is from June until cold weather. This is the fly by which the horse is often so much frightened.

When the first named species is depositing its eggs on his legs he does not notice its presence, but let one of these red-tailed flies come near, and he exhibits signs of the utmost fear. This fly places its eggs upon the lips of the horse, which is effected by darting suddenly forward and almost instantly fixing the eggs to the hair, notwithstanding the horse uses every means in his power to prevent it. When a horse is seen to stamp violently, throw his head up, down, and sideways, with a sudden motion, and run in the pasture as if to get away from some pursuer, it is because of the presence of this fly. I have seen horses exhibit such fear at the approach of one of these little insects, that it was almost impossible to hold or control them.

There are also two other species of bot flies which trouble horses to some extent. These are called *Gastrophilus nusalist* and *Gastrophilus pecorum*. Their habits and appearance are much like those of *Gastrophilus equi*, but

they are smaller and not sufficiently numerous to cause much trouble. From all these pests a little care and attention, at the proper time, will keep the horse free.

Urging all farmers to use every available means, and to use such means in season, and thus prevent parasites of all kinds from injuring their stock, I will close without mention of numerous smaller parasites, but yet, perhaps, of sufficient interest to form the subject of another discourse in the future.

REPORT

OF THE

GEOLOGIST & CURATOR STATE CABINET

For 1875 and 1876,

WITH SOME

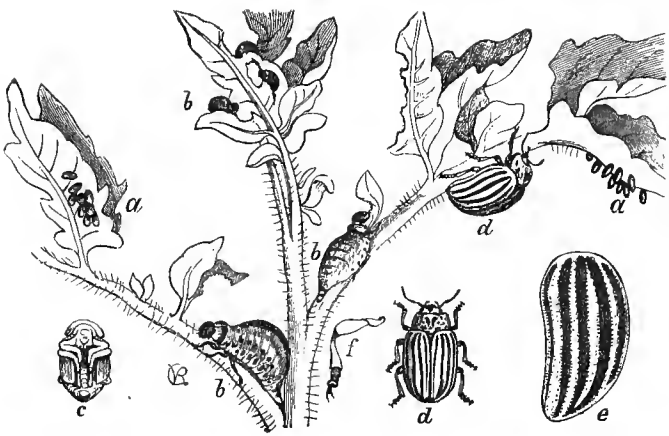
SUGGESTIONS AND DIRECTIONS

AS TO HOW WE MAY

PROTECT OURSELVES AGAINST INSECT ENEMIES.

By HIRAM A. CUTTING, A. M., M. D.,
STATE GEOLOGIST AND CURATOR.

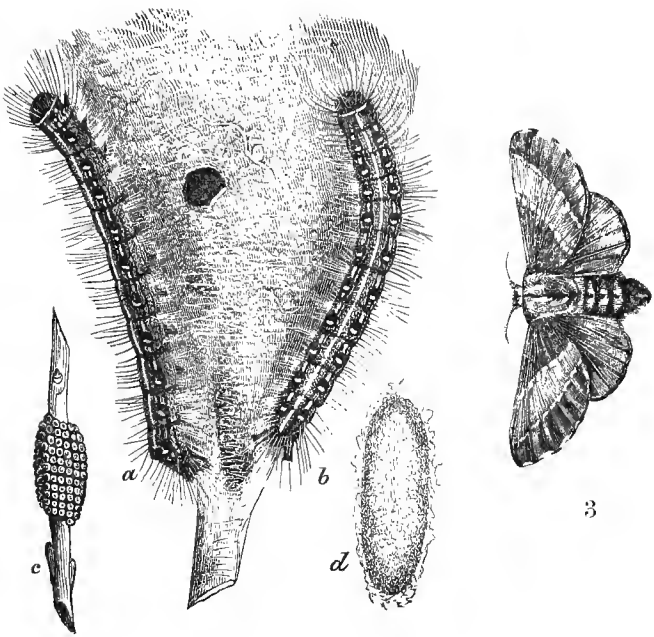
RUTLAND:
TUTTLE & COMPANY, BOOK PRINTERS.
1876.



TEN-LINED POTATO BEETLE—COLORADO POTATO BEETLE—DORYPHORA DECEMLINEATA.—*Say.*

a, a, eggs; b, b, b, larvæ of different ages; c, pupa; d, perfect insect; e, right wing cover enlarged; f, leg enlarged.

See page 11.

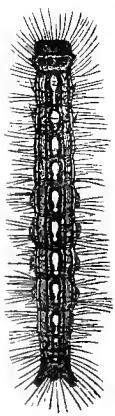


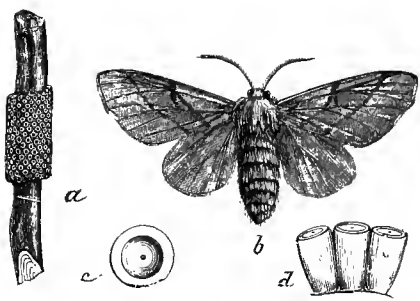
TENT CATERPILLAR OF APPLE TREES—CLISIOCAMPA AMERICANA.—*Harris.*

All natural size; a, larva full grown, side view; b, larva full grown, back view; c, cluster of eggs on a twig; d, cocoon.

Fig. 3. Moth, color, reddish brown.

See page 19.





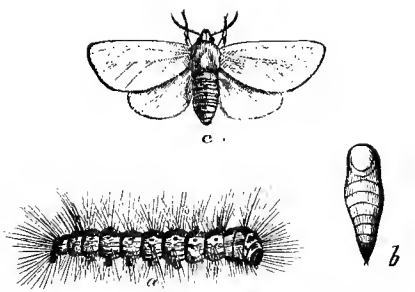
4

FOREST TENT CATERPILLAR—CLISIOCAMPA SYLVATICA.—*Har.*

Fig. 4. Caterpillar full grown ; natural size.

a, eggs ; b, female moth, natural size ; c, enlarged view of egg from top ; d, enlarged view of eggs from side.

See page 21.



WEB WORM—HYPHANTRIA TEXTOR.—*Harris.*

All natural size. a, caterpillar ; b, chrysalis ; c, moth.

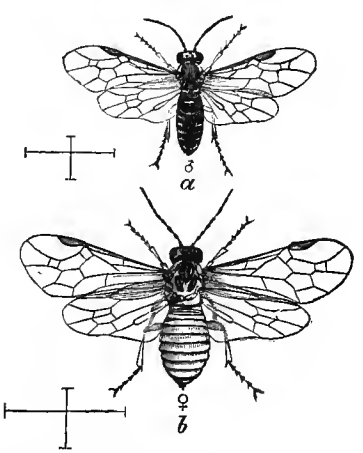
See page 22.

Fig. 1.

THE CURRANT WORM—NEMATUS VENTRICOSUS.—*Klug.*

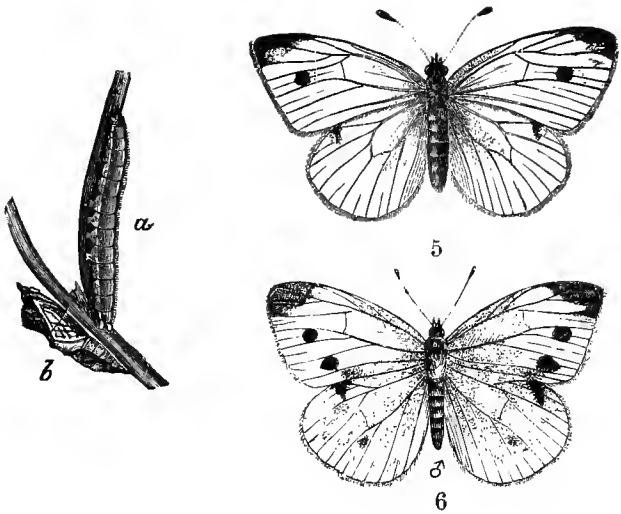
a, a, a, different stages of growth; b, a single segment of the caterpillar magnified.

Fig. 2.



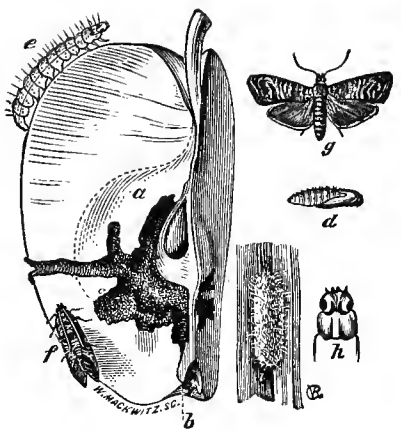
Adult specimens enlarged. The marks at the side represent the actual measurement with wings spread. a, male; b, female.

See page 22.



CABBAGE WORM—PIERIS RAPÆ.

Fig. 5. Butterfly of the cabbage worm, male. Fig. 6. Female. The female is distinguished from the male by having two round spots, rarely three, on the wings. The body of this butterfly is black above, with white wings. a, cabbage worm; b, chrysalis. See page 23.



CODLING MOTH—CARPOCAPSA POMONELLA. —*Linn.*

a, apple eaten by larva; b, spot where egg is laid and the young worm enters; c, cavity made by larva; d, chrysalis; e, larva full grown; f, moth with wings folded; g, moth with wings expanded; h, head and first joint of larva (enlarged); i, cocoon.

See page 24.

ROUND HEADED APPLE TREE BORER—SAPERDA BIVITTATA.—*Say.*

Figures all natural size. a, larva full grown; b, pupa; c, perfect beetle.

See page 25.

REPORT OF THE STATE GEOLOGIST.

To His Excellency, ASAHEL PECK,

Governor of Vermont:

SIR:

I have the honor to present the following report in relation to my department, for the years 1875, and 1876. As there is no appropriation by the Legislature, to enable me to examine the mining sections of the State, or even collect the statistics of the same, I am, of course, unable to give a definite report.

The marble interests, notwithstanding the hard times, are still, as they must be for years to come, on the increase. They pay reasonable profits on investments made, and as the marble improves with depth in most of the quarries, the future prospect is flattering.

The quarrying of granite, and porphyry, has been on the increase, and it is found that our granites when polished are scarcely inferior to the Scotch granites, so much used in Europe, and recently in this country. Among the more promising granite quarries may be mentioned those of Blue Mountain in Ryegate, the quarries in Barre, Craftsbury, Brownington, Newport, Kirby, Victory, and Brunswick. Preparations are now being made to quarry porphyry in St. Johnsbury, and Waterford.

During the two years here reported I have been conferred with by letter, or otherwise, in one hundred and sixty-three cases, in relation to supposed recent finds of minerals in Vermont. In most cases the amount was too small to be of value, but in some the ore was good, and appears to be in sufficient quantity, and quality, to warrant further examination and development. This will in most cases doubtless be made as soon as the revival of business and prices of metals favor the outlay. An extensive bed of iron ore (Magnetite) in Concord gives great promise.

There are, at present, enquiries by several parties for white silicious earth, and as there may be various deposits unopened in the State, I would suggest that parties owning such send me samples; and if of good quality, I may be able to put them in communication with purchasers.

ADDITIONS TO THE CABINET.

We have been enabled to make the usual increase in our specimens. Many of them have been through the courtesy of friends, and we are still indebted to the various railroads, not only in the State, but elsewhere, for their aid in bringing those collections together. It would give us pleasure to be more personal in our thanks, and give the names of all rendering aid in this collection, but it is hardly possible.

MINERALOGY.

In this department we have received various specimens from different localities in the State, and to aid in the collection of Vermont specimens I have purchased some beautiful geodes from Illinois, which I will give in exchange for

any Vermont specimens desired. It is often that, in the homes of our citizens, I find a specimen or two that should be in our State collection; but they are unwilling to part with them, as they are kept for their beauty. I shall now be enabled to exchange, giving specimens foreign to Vermont, and more beautiful to grace our homes, for specimens desired in the State collection.

ORNITHOLOGY.

The following are the names of the birds, in part, that have been added, or in other words are the specimens added in 1875. Those of 1876 are not yet in order for names, and as no full list can be given, I give none of this year's acquisition.

No. Specimens.	COMMON NAMES.	SCIENTIFIC NAMES.	AUTHORITY
1	Bunting, Snow	Emberiza nivalis,	Linn.
2	" Towhe	Fringilla,	Gm.
1	Bittern, Least	Ardea exilis,	"
1	Bobolink,	Emberiza oryzivora,	Linn.
1	Cuckoo,	Coccygus Americanus,	Linn.
1	Duck, Oldwife	Anas glacialis,	Wilson.
1	" Velvet	" fusca,	Wilson.
1	" Ruddy	Erismatura rubida,	Bona.
2	" Barrows' Golden eye	Bucephala Islandica,	Baird.
1	Eagle, Bald	Falco leucocephalus,	Linn.
1	" Osprey	" haliaetus,	Linn.
1	Godwit, Hudsonian	Limosa Hudsonica,	Swainson.
1	Hawk, Pigeon	Falco columbarius,	Linn.
2	Kinglet, Golden	Regulus satrapa,	Coues.
1	Martin, Purple	Hirundo purpuria,	Linn
1	Meganser, Red-breasted	Mergus serrator,	Linn.
1	Nuthatch, Redbellied	Sitta Canadensis,	Linn.
1	Owl, Acadian	Strix passerina,	Linn.
2	" Great horned	" Virginiana,	Gm.

No Specimens.	COMMON NAMES.	SCIENTIFIC NAMES.	AUTHORITY
1	Pewee,	Muscicapa nunciola,	Wilson.
1	" Wood	" virens,	Linn.
2	Plover, Piping	Charadrius hiaticula,	Wilson.
1	" Ringneck	Acgialitis semipalmatus,	Coues.
2	Redpoll, Yellow	Fringilla linaria,	Linn.
2	" Lesser	"	
1	Rail, Carolina	Porzano Carolina,	Saml.
1	Sparrow, Java	Fringilla,	Linn.
1	Sandpiper, Solitary	Fringa solitaria,	Wilson.
1	" Spotted	" macularia,	Wilson.
1	Teal, Green-winged	Anas crecca,	Wilson.
1	Tern, Least	Sterna minuta,	Wilson.
1	Thrush, Wilson's	Turdus mustelinus,	Wilson.
1	" Wood	"	
1	" Golden crowned	Motacilla aurocapilla,	Linn.
1	Vires, Yellow-throated	Muscicapa sylvicola,	Wilson.
1	Warbler, Black and yellow	Sylvia magnolia,	Wilson.
1	" Yellow	Motacilla petechia,	Linn.
1	" Cape May	Sylvia maritima,	Wilson.
1	Yellow Bird,	Fringilla tristis,	Linn.

We still desire specimens of rare birds killed in Vermont, and wish such when killed sent to us immediately by express. As there is an appropriation to pay express charges, such charges need not be prepaid. Should it be the desire of parties donating the birds that their names should appear on the specimens, a letter stating that fact, with name and residence, must be sent by mail. If birds are caught in traps, do not send them alive, as their plumage will be spoiled, but kill by pouring a spoonful of chloroform down their throats, and then wrap up in a paper before boxing, so as to retain their feathers in the most natural position.

*OOLOGY.

Though we have much increased our collection of eggs, more are wanted, and we should be glad to make arrangements for the same in different parts of the State. As soon as possible they will be mounted on the stands with the birds, and we hope soon to show the egg of every species, as well as the nests.

Nothing forms a more attractive feature in a museum, or is more acceptable to amateurs, than the nests and eggs of birds. These should be collected whenever they are met with, and in any number procurable for each species, as they are always in demand for purposes of exchange. Dozens of eggs of *any* species with their nests (or without, when not to be had) will be gladly received.

Nests require little preparation beyond packing so as to be secure from crumbling or injury. Each one should be placed in a box or ring of paper just large enough to hold it. The eggs of each nest, when emptied, may be replaced in it and the remaining space filled with cotton.

Eggs, when fresh, and before the chick has formed, may be emptied by making small pin-holes on opposite sides, and then blowing or sucking out the contents. Should hatching have already commenced, an aperture may be made in one side by carefully pricking with a fine needle round a small circle or ellipse, and thus cutting out a piece. The larger kinds should be washed inside, and all allowed to dry before pack-

* A pamphlet has been published by the Smithsonian Institution in regard to the collecting of nests and eggs, which may be obtained upon application.

ing away. If the egg be too small for the name, a number should be marked on it with ink corresponding to a memorandum list. Little precaution is required in packing, beyond arranging in layers with cotton and having the box entirely filled. It is always better to wrap each egg in a loose coat of cotton before arranging in layers, and they should be packed in small wooden boxes.

Cracked eggs should have strips of tissue paper pasted over the line of fracture; or the crack may be painted over with collodion while the sides are pressed together.

CRANIOLOGY.

We now desire, to complete our set of Vermont mammals, the skull of the wolf, (Canis lupus,) and catamount, (Felis concolor). If any party will furnish them, we will make fair remuneration.

CONCHOLOGY.

I am glad to report an increase in the number of our shells, which will soon be arranged for exhibition. We have now nearly one hundred named species. We trust the friends of this specialty will not forget that they can send them nicely through the mail, and that we will exchange, giving specimens from other localities, as soon as we can get them named and in order for distribution.

ENTOMOLOGY.

In this department many additions have been made, and as there is much interest in relation to injurious insects at this time, I deem it best to answer in this report, in part at least, the numerous letters I receive; by a description of

such of our insect enemies as I am so often enquired of in relation to ; and notices of such means of destruction as are deemed best for their extermination. In a letter before me, I am asked: "What is science good for, if scientific men are baffled by one little insect which they cannot devise means to exterminate ?"

Science is not baffled, but, like Hercules in the old fable of the wagoner, can help you, and will help you, only when you help yourselves. I may now hear you ask: "How we may help ourselves ?" or how Vermont alone can help herself. We may safely calculate that the insect ravages in Vermont for the year 1877, will exceed three millions of dollars. Now is it too much to say that a concerted action on the part of all agriculturists would decrease this damage one half? Did science have full control of our legislature, law would require, and enforce, the necessary concert of action ; and while agriculturists would groan under imaginary tyranny, they would reap the reward. As the agricultural interests control the legislature, ought they not and will they not take their best interests under consideration, and do something for themselves ?

First, then: A law should be passed authorizing the selection, and providing for the payment, of a competent commission ; perhaps of three persons, for this State ; to be selected for their merit and ability for the work ; not for political influence. This commission should sub-divide their work in such manner as to thoroughly investigate the habits, and times of appearance of agricultural pests; the effects upon them of all cheap materials which have been, or may be used as destroying agents; and to fully determine the

proper times of applying the same. The members of this commission should have sufficient remuneration for time and labor, so that, if necessary, they could temporarily abandon other pursuits without damage to their pecuniary interests.

It is only by the association of several careful observers and investigators that the most useful results can be obtained.

Secondly. When this information has been accumulated, it should, in compact form for easy reference, be widely published in newspapers, and in pamphlets, for a general distribution to all farmers.

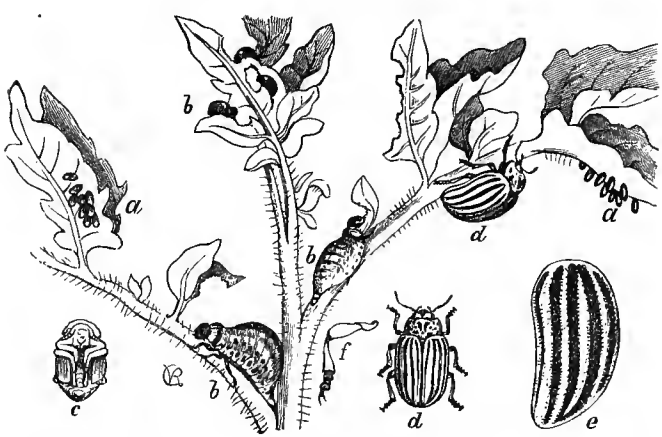
Thirdly. When such information has been made general, compel by legislation, and impress the acts and the beneficial results of the same upon the community, through your agricultural societies, the Board of Agriculture, and the newspapers of the State. You already protect your birds by law, which is one step in the right direction. Can you, in fact, find an intelligent farmer in the State to-day, that would not cheerfully obey a judicious law to concertedly counteract the injury of the advancing potato bug? The rights of the intelligent who are disposed to help themselves and each other, can only thus be protected against their indolent neighbor who allows his fields to be the nursery of insects of destructive tendency, which overrun surrounding farms to such an extent that no industry can protect against them.

This, then, allow me to say to the agriculturists of Vermont; that a successful campaign against your insect enemies can only be brought about by the demand of yourselves; and that legislative enactments must furnish the

means and give the power of action. Further: It must also protect this concerted action from the thriftless ignoramus that don't care for himself or neighbors. The fact is, that the ravages of hostile insects represent a condition of war, and it is only by organization, and appropriate weapons, that they can be conquered. The proper subjects for consideration are the materials to be used, the best time to make the attack in force, and the weapons to be employed. It is entirely useless for us to fold our arms and exclaim: "It is the will of God!"

The Colorado Potato Beetle.

Doryphora decemlineata, Say.



a, a, eggs; b, b, larva in different stages of growth; c, the pupa; d, beetles; e, elytron magnified; f, leg magnified.

This pest is now really in our midst, and though not as yet in sufficient numbers to do much harm, its previous history ought to give us warning. The great interest felt on account of this intruder has been manifest by the countless bugs of all descriptions that I have received by mail this

season, with the enquiry: "Whether it is a potato bug." Nine times out of ten I could say it was not; but the number of actual potato beetles has led me to the belief that there is hardly a town in the State that has not in it the dreaded pest; in small numbers, it is true, but yet if not immediately attended to, two seasons more will blight our crop of potatoes as elsewhere. That all may recognize this pest, I will give something of its appearance, history and habits.

This bug, so called, is, strictly speaking, a beetle, and is known to naturalists under the name of *Doryphora decemlineata*. Like other higher species of the Coleoptera, it passes through a complete metamorphosis, but, unlike many other beetles, it confines itself during its entire life to the same species of vegetation, and, unhappily, selects as its first choice the potato. This beetle, however, is not, like many of our pests, an importation, but an original native of the far West. Its name would indicate Colorado as its birthplace, but historical facts do not confirm it, as the bug committed severe depredations in Nebraska and Kansas before it was ever seen in Colorado, and the farmers there consider it of Eastern origin. It is, however, described by naturalists as a native of the Rocky Mountains, from whence it came as soon as the cultivation of the potato offered a stepping stone to civilized life. I am, however, from its history which I have traced back as far as possible, of opinion that, if it came from the Rocky Mountains, it came down the fertile valley of the Missouri, or some of its branches, rather than across the desert of near five hundred miles intervening between the cultivated lands of Colorado, and the fertile

plains of Kansas; and it is quite as likely that it had its origin in some of the fertile valleys or grassy plains of Nebraska.

That its native place is far west of the Mississippi no one can doubt. That it is a great lover of the potato plant is equally certain; yet it can exist upon other food when potatoes fail, but first selects the tomato and other plants nearly allied in properties to the potato leaf; but such plants are seldom attacked until the potato fields are fully devastated. The eggs of this beetle are deposited, to the number of seven or eight hundred, by each female, at intervals during from twenty-five to forty-five days, on the leaves of the potato, in regularly arranged clusters of from twenty to thirty eggs each. They are of an orange color, and always on the under side of the leaf. In about one week after they are deposited they hatch into larvæ, which feed upon the foliage about two weeks, though some fix the period at seventeen days. Their growth is quite regular, and when full grown they are three-eighths of an inch in length. Upon their sides they have two rows of slight protuberances tipped with black, ten in the lower row and nine in the upper; when full grown there is a faint trace of a third row below the two, and four black dots, forming the back of the neck, or thorax as it is more properly called in the insect. Its head is also black, and it has a black ring round its thorax. It has six legs, the first pair coming out of the thorax, and the others immediately behind, or on the front part of the abdomen. Its body is cream color. When full grown they descend to the ground, where they change into a pupa state

near the surface. The perfect beetle appears in a little less than two weeks, pairs when about one week old, and a week later commences the deposits of eggs, as before described. From three to four broods will be hatched in a season. The statements of time are, however, liable to vary, being longer or shorter, according as the weather is more or less favorable to their development.

The mature beetle, as its name indicates, has ten lines of black lengthwise of its wing covers, five on each side, the ground being a medium yellow. It has several black spots upon its head and thorax, also six legs, and pink gauze wings under the striped wing covers described. It passes the winter in the perfect beetle state, burrowing in the ground beneath the frost, coming out unimpregnated in the spring, just in season to lay its eggs on the young potato plant.

Bad as these beetles are, they are not so bad as popular opinion makes them. Their first onset is the most severe, and farmers accustomed to give up to imaginary evils will talk about the extermination of the potato. Of that there is no danger from this cause. In Iowa, in 1870, the beetles were very abundant, so much so that they swarmed over barns and outhouses, and also entered dwellings so that you could hardly sit down or walk without crushing them, yet the crop of potatoes was the largest ever known, and they were retailed in the streets for twenty-five cents per bushel. This abundant crop was raised by every one planting in anticipation of high prices, thus bringing the opposite result.

By some this beetle is considered poisonous, but from no

just cause, as it can be picked from the potatoes day after day, by whole families, with no bad result. Large quantities of them in the state of putrefaction, like all other animal matter, is disagreeable, and, doubtless, unhealthy, and they should never be left to putrefy, but be burned or destroyed with boiling water, and then buried. As they are voracious feeders, they may be killed with poison, like arsenic or Paris green, mixed with flour, and dusted on the potato leaves. As these substances are very poisonous if swallowed or inhaled, great care should be taken in their use.

As regards their depredations in the New England States, of course we have much to fear, and yet we have some things in our favor. First, its natural enemies. The "lady bird," which, perhaps, is more generally known as the lady bug, has been very abundant this season, causing the destruction of myriads of plant lice, and they need but encouragement to assist the farmer in the destruction of the potato beetle, as they are a deadly enemy. The eggs of the "lady birds" are very much like those of the potato beetle in color, but are smaller and not so many in a cluster, but always laid in close proximity to those of some other insect. As soon as they hatch, they commence their war of extermination, and, as they are voracious feeders, they follow it up almost unceasingly. This lady bug is about two-thirds the size of the potato beetle when fully grown, of a yellowish red color, with two or more black markings on each wing cover, being shorter and more thick-set than the potato beetle. In fine, they are about the size and shape of a half pea. There are several varieties, but all are the

friends of the farmer, and should have special protection. The spined soldier bug and the banded robber bug also prey upon the larvæ of the potato beetle, as well as at least six other cannibal foes common to New England, although those enumerated are the most important.

Secondly. Our winters are more severe than the winters West. Jack Frost creeps deeper into the ground, and must overtake many of the ten liners that supposed themselves safe from cold. This year brings skirmishing parties into our midst, and in two years it is probable the main army will test our potatoes and our climate, so let us be ready to give them a *warm*, if not a welcome reception.

The material used in the warfare against this intruder has generally been Paris green dusted on the leaves when wet with dew, while the beetles are in their larval state, or mixed with water at the rate of one tablespoonful of the green to a pailful of water. When applied dry it is better to mix with ten parts of flour; and great care should be taken not to inhale the dust, as it is very poisonous. When in solution it must be almost continually stirred, or the green will sink to the bottom of the sprinkler, as it is not soluble in the water.

C. V. Riley, of Missouri, says that quite as good results may be obtained in using the ingredients from which green is made, as from the finished article. The Paris green costs say 37½ cents per pound, and the demand is often so great that it cannot be obtained just when wanted, especially in back towns. The following directions for making green, from Brande's Chemistry, are practical: Dissolve two pounds of sulphate of copper (blue vitriol, costing fif-

teen cents per pound, or thirty cents,) in a gallon of hot water, keeping it in a stone jar. Dissolve in another large jar, one pound of common white arsenic (costing about six cents,) and two pounds of saleratus or pearlash, (cost sixteen cents,) in forty-four pounds of hot water, stirring well till thoroughly dissolved. These articles, costing fifty-two cents, will make about five pounds of Paris green, costing about $1.88.

This can be kept in solution and mixed in proportion of one part of the first and five of the last solution, as they are needed. The green immediately begins to precipitate in a fine powder, and is much more convenient for use in solution than the dry article. Prof. Riley says that Paris green can be in this way used without danger, and all agree that in solution or mixed with flour when dry and dusted on it is the unfailing remedy.

Dr. Le Conte advises the use of large atomizers for not only the destruction of the potato beetle, but of all insects that can be killed by a solution. This idea is worthy of consideration, and it may, doubtless, prove invaluable.

Next to the potato beetle in number of enquiries comes the

Striped Squash Beetle.

Diabrothica vittata, Fabr.

This beetle appears on cucumber and squash vines, as soon as they are through the ground, and frequently devours them all in spite of the usual preventives used. They need little description, as they are well known by the yellowish stripes upon each wing cover. They lay their eggs in June, or soon after their appearance, and the larva arrives at ma-

turity in about a month after the egg is laid. The larva remains in the pupa state about two weeks. We usually have but two generations in a season. It remains through the winter in the pupa state. The grub often hollows out the stem of the squash or cucumber vine, below the ground, the last of June or first of July, and sometimes eats the upper portion of the root. Should this food get short they may be found in the stem above ground. They, however, do not do great damage either in the second generation, or in their grub life. Covering the vines with a box covered on top with muslin, has been considered the only sure remedy; though powdered charcoal, lime, and sometimes ashes, can be used with benefit. In many cases, however, the material sprinkled on the leaf is as bad as the beetle. If a handful of shavings be burned near the hills in the evening, many of them will fly into the flames. After various experiments, I have become satisfied that covering the hills with common newspapers, is much the best means to be used; besides, you get an accelerated growth of the plants. Just as soon as they break ground, or, perhaps better, a day or two before the plants appear, open a newspaper to its full size, and spread it over the hill, letting it lie close on the ground, and fasten it in place by hoeing the dirt on to the edges, so that no gusts of wind can disturb them. The plants thus covered will grow at least a third faster than those not covered, are safe from the beetles, and more healthy in every way, producing blossoms several days sooner than those not covered. It is seldom that once covering will not answer all purposes, but should one be torn off from any cause, it can easily be replaced. I have tried

different colors of paper, and find white or blue paper best adapted to the purpose. Other colors seem to give a paler green or sickly appearance to the plants. Newspapers are easily obtained, and are just as good as clear white paper. It will be seen, also, that this is a protection against late frost, and I believe that every person that tries this method of protection will ever use it with entire satisfaction.

The Tent Caterpillar.

Clisiocampa Americana, Harris.

This caterpillar is well known to all, yet all do not understand its habits. The eggs are laid by a night flying moth, in August, or in the southern part of the State, doubtless, in the last part of July, in oval rings, round the smaller twigs. These egg rings contain some three hundred eggs each, and are covered over with a mucilaginous coating which answers the double purpose of keeping out the water, and food for the young when they hatch, to give them sufficient strength to crawl down the limb to the first fork, where, by crawling back and forth, they weave from a spinneret in their mouth, the tent in which they live. From this tent they sally forth twice a day for food, eating voraciously. On an average, each caterpillar will eat two apple leaves a day, and no tree can long live under such a vital drain. As the weather gets warm, when they return from a meal, instead of going into their tent, they will go to rest upon the outside. Those coming in later and finding no room, will crawl over the sleepers, spinning all the time until they are covered, and another story is added to their tent. Thus from time to time it is increased with their

growth until their food gives out, or their caterpillar life is spent, when they lose their social habits, and wander off to find other food, which they are seldom able to do, or find suitable places in which to spin their cocoons. These are light colored, with a tinge of yellow, and may generally be found attached horizontally, to the under side of fence rails, or other protected places. They remain in these about three weeks, when such as have not fallen a prey to the ichneumon fly, as many do, come forth to lay their eggs, as before described. The question so often asked is: "How to destroy them?" I will first tell you how you ought not. Some flash gunpowder on their nests; others burn them with a torch; while some put on kerosene and burn, and others saturate with oil, to kill them. All these methods are destructive to the trees, and should never be employed. Upon a moment's reflection it will be seen that the quickest and easiest way is to cut off the twig containing the eggs. After the leaves have fallen, on a frosty morning, the eggs may be readily seen as a dark band on the twigs, as the frost does not so readily adhere to them. When you cut them off always burn them. If this method is neglected, watch your trees when they first hatch, and with a stick remove the entire nest early in the morning, or just at night, as they feed and are consequently scattered over the branches both in the middle of the forenoon and middle of the afternoon, and some stragglers are absent all day. If they are still neglected, as they should not be, there is no sure way to rid your trees of them but to put on gloves and clean them off with your hands. You can kill by crushing, or have an attendant with a pail of hot water, and put in

such branches as you can cut away, or do not crush. Every tent found, whether on orchard or forest tree, should be destroyed.

Nearly akin to this insect is

The Forest Tent Caterpillar.

Clisiocampa sylvatica, Harris.

This caterpillar, for some years past, has been destructive to forest trees as well as apple orchards, yet what I have previously said will equally well apply to this species, only its eggs which surround the twig in the same manner, form a complete cylinder, holding its full size from one end to the other, uniform in diameter, and cut off squarely at each end, while the egg masses of the other are oval rings, rounded at each end of the mass. They are a more hardy species, and after having stripped one tree of its leaves, will travel in troops to another, ascend, and there make their home. This can easily be prevented by putting tar or printer's ink about the trunks of trees not infested. The habits of this insect are not the same as those of the other. While they spin a thread they do not form a tent between the branches, but, resting upon the smooth side of the trunk or branch, their thread lies between and beneath them, so it does not make much show. They feed night and morn, sometimes in the night, and are more voracious than the former. While the former appear almost every year, this species is seldom plenty but a year or two at a time. They will hardly be seen for three or four years, and then reappear in abundance as before.

The reason for this seems to be that their natural ene-

mies increase more rapidly upon abundance, than they do, and, after overpowering them, almost die out also, and then the caterpillar gains ground again. The same means of killing should be employed as before.

Next to the caterpillar comes the

Web Worm.

Hyphantria textor, Harris.

This is often supposed to be the second brood of the Tent caterpillar, but is a different species altogether. The last of July a small white moth lays her eggs upon the end leaf of a branch, which soon hatch. The young enclose the end of the branch in their web, feeding only upon the pulpy parts of the leaf, leaving the skeleton behind. They extend the web over other leaves as soon as they are needed for food. When fully grown, they descend the tree, and pass the winter in the pupa state in the ground.

The best way to rid your trees of this pest, is to clip off the end of the branch as soon as the worm appears. On no account delay, as if you do, they will slip through your fingers, and much increase your labors the next season. If they are neglected until they cover more than you desire to prune away, kill as you do the Tent caterpillar. This you can do at any time, as they never leave their tent as the others do, but extend it as they desire more food.

The Currant Worm.

Nematus ventricosus, Klug.

This, like the caterpillar, needs no description, as it may be found in its season upon currant and gooseberry bushes, in all parts of the State.

The perfected insect lays its eggs on the under side of the leaves, generally beside the veins, but sometimes in clusters. In from six to eight days, according to the weather, they hatch, and commence feeding. They continue their work upon the bushes, until they are bare of leaves, and then, whether fully grown or not, go down into the ground and form little black pupæ, varying in size according to the way the worm is fed. Emerging in about two weeks, they lay their second brood, which pass the pupa state in the ground as before, but do not emerge until the following spring. Powdered white hellebore is, perhaps, generally used for their destruction, but is no better than any other dust. Any dust that touches them is lodged in their spiracles, or breathing-pores, and soon produces death. Dust from the road, dried fine plaster of Paris, or any finely pulverized substance, will answer. The Grafton fertilizer, which was finely pulverized quartz, was the best material I ever saw for killing them. It possessed the requisites of great fineness and perfect dryness, so it would make a dust easily. The hellebore is an excellent preparation for the purpose, but might poison the fruit. Gum aloes is, when fine, equally penetrating, and less dangerous.

Cabbage Worm.

Pieris rapæ.

Twenty years ago this centennial year, this obnoxious European insect landed in Quebec, and from that beginning has made itself familiar with not only New England, but most of the United States, as well as Canada.

It is susceptible to the dust treatment, but as that gets into the cabbage head and injures it, it cannot be used to

advantage. There is, however, a little parasite, *Pteromalus puparum, Linn.*, which deposits its eggs in the pupa of the cabbage butterfly, and the young find food enough to develop forty or fifty from one pupa, to again feed upon this obnoxious insect. This parasite is not found in all places where the cabbage worm is, as they are not so rapid travelers, but, doubtless, soon they will be held in check by this little friend of mankind.

The Codling Moth or Apple Worm.

Carpocapsa pomonella, Linn.

This is another imported insect, but is, doubtless, found everywhere where apples are raised, and so has become domesticated in its American home. About the first of July, in this State, the night flying moth comes from his silken cocoon, which was hid under some bit of bark, or sliver on the fence near by. After pairing the male dies, but the female may be seen in the dusk of night flitting around the apple tree, laying her eggs in the blossom end of the little apples.

In about a week the egg hatches, and the worm eats his way into the apple, where it lives for about a month, when it bores its way out through the side, and escapes to some sheltered place, where it builds its cocoon, as stated; but this time coming out in about twelve days, laying eggs as before, this brood giving us the wormy apples in the fall. What worms survive build cocoons as before, to come out perfected the next summer. The first brood is very small, but the second is fifty to one of the first, or even more.

Our protection against this insect is very difficult, and so most people do nothing. Putting wisps of straw round the

tree, to furnish shelter for cocoons, and then taking off and burning, or scalding it; removing all rubbish from near the trees, which could afford shelter; allowing cattle or pigs to run in the orchard to pick up the fallen fruit, and many other things are devised, but all fail in keeping them only temporarily in check. It is a great task to do all this, but in the spring the destruction of one cocoon, and many may often be found where apples have been kept through the winter, saves at least one hundred apples from contamination. It will be seen that their destruction is of great importance.

The Apple Tree Borer.

Saperda bivitata, Say.

This is a native American, born and bred in the mountains, feeding upon the wild crab, mountain ash, and various other trees. It comes out of the trunk, usually in June, and always in the night, in its perfect state. Resting by day, in the night time it flies from tree to tree for food and companions. Though they feed upon the bark of branches where it is tender and succulent, they lay their eggs on the bark at the foot of the tree, where the young, as soon as hatched, commence to burrow in the bark. For the first year they live mostly in the bark, but, towards the last of the season, advance into the sap wood. Frequently in young trees the bark over them will crack and allow their castings to fall out, and thus they may be detected. They remain in the tree three years. As the time comes for their exit, they eat their way to the bark, thin that somewhat, and go into the pupa state to emerge perfected in about four weeks.

The best remedy is to prevent the successful laying of eggs, which may be done by smoothing and then soaping the bark. If such is done near the ground only, they will lay their eggs at the junction of the largest limbs, or higher up on the trunk, so the scraping and soaping wants to be thorough. If the borers are really in the trees, there is no way except to kill them, or cut them out one at a time. A small piece of whalebone is the best to kill them with, by pushing it into their hole. A piece of wire will answer. When the bark is killed over them it is just as well to cut them out. The application of the soap is necessary in May. Either soft or hard soap will do, but if hard soap is used a thin piece had better be crowded down into each principal crotch of the tree, so that the rain may wash it down the trunk. Do this, of course, after having washed the tree with strong suds.

Though many other insects have been enquired after, the foregoing are the principal ones. As in times past, I shall be willing to give, by letter, to the enquirer, such information in relation to insects as I may be able to impart, yet would advise that all study the habits of pests; and when they are enabled to fight one with success, let it be known through the press, that all may profit thereby.

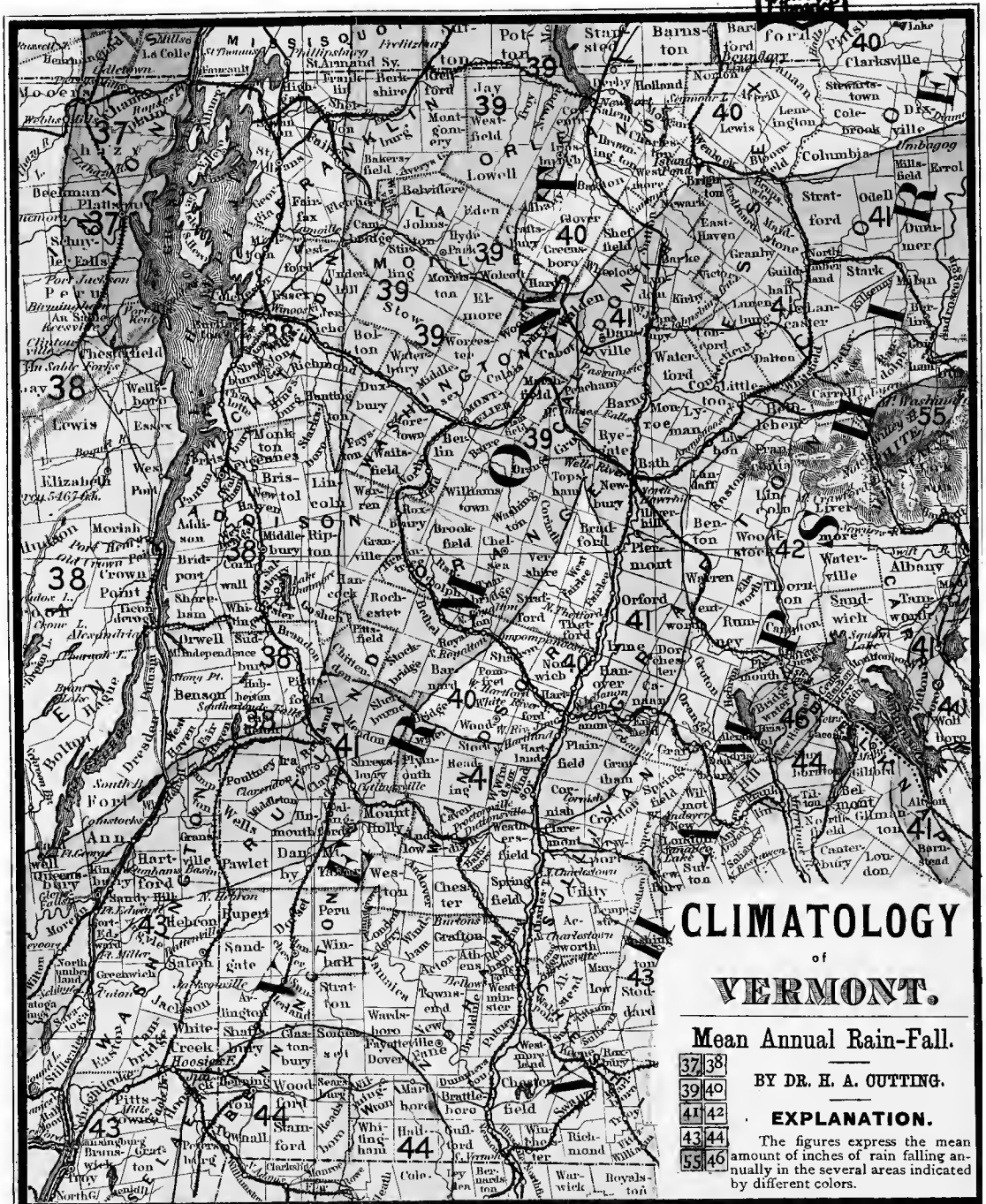
Most respectfully yours,

HIRAM A. CUTTING, M. D.,

State Geologist and Curator State Cabinet.

Lunenburgh, Vt., August 31, 1876.

Cornell University Library



METEOROLOGICAL TABLES

AND

CLIMATOLOGY OF VERMONT,

WITH MAP SHOWING THE RAINFALL;

ALSO,

SUGGESTIONS AND DIRECTIONS ABOUT FORETELLING STORMS.

By HIRAM A. CUTTING, A. M., M. D.,
STATE GEOLOGIST AND CURATOR.

MONTPELIER:
J. & J. M. POLAND, OFFICIAL STATE PRINTERS.
1877.

CLIMATOLOGY OF VERMONT.

Observations made in the interests of meteorology, and collected and reduced under the patronage of our government, have shown that though our storms are irregular, that our hills and valleys are rendered fertile by the moisture brought from the Gulf of Mexico, by the great south west current. This is modified by the physical contour of the country, and by the great atmospheric current coming from the Pacific, which, though it loses most of its moisture before it reaches us, it modifies our climate, as we get westerly winds at least three fourths of the time; and sometimes when we get falling weather, this wind, meeting the moisture coming inland from the Atlantic, condenses it, causing showers, and now and then extensive storms. Thus the atmospheric disturbances generated thousands of miles away, give us in connection with our local storms sufficient moisture to render our State fertile, even to the mountain summits.

Through the investigations made by Prof. Joseph Henry, of the Smithsonian Institute, we see that our great north east storms have their origin within the tropics. The great current of the south east trade wind infringes on the north east trade wind, and produces the cyclones so destructive on the coast of Florida and the West Indies. The cyclone thus generated moves along the coast with diminished violence, producing our north east storms. Sometimes this disturbance originates among the Rocky Mountains, sweeping over the continent. This takes place oftener in August or midsummer; while in autumn and winter we are more dependent upon the Gulf storms. From observations of the Signal Service, it is shown that from seven to thirteen areas of low barometer are developed per month within or upon the borders of the United States. From one to three of those pass directly over Vermont. As a rule rainfall increases as you go towards the equator, and decreases towards the poles; thus we should expect more rainfall in the southern part of the State, and such is true, yet its geographical distribution depends somewhat upon the contour of our State, as the map shows. Though they may receive more rain, it is in no way certain that they may not more often suffer from drought than other sections, as the nature of the soil and the greater or less humidity of the atmosphere from surrounding forests or ponds may much modify evaporation. The amount of vapor in the atmosphere regulates the intensity of the sun's rays, as well as preventing the radiation of the sun's heat from the earth, which radiation rapidly aids evaporation of moisture. Thus in some sections crops may severely suffer from drought, while in others they may not, yet

the rainfall for the time may be equal. Thus it will be seen that the preservation of vegetation upon our hilltops and mountains not only modifies the effects of drought, but, carrying out the same reasoning, moderates the extremes of winter. In relation to soil, it is easy to ascertain which will retain the most moisture, by taking a given amount that is perfectly dry, and see how much water you can add to it without its leaching, and then how rapidly it loses it by evaporation. These experiments show that while the usual soil of our hillsides is losing three fourths that of our valleys, which will not at first retain as much, will lose nine tenths of what it at first absorbed, thus showing why our hills are always green, and hill land more sure not to suffer from drought.

The foregoing map shows, not only the annual aqueous precipitation for the State, but for a large part of New Hampshire, and a part of Massachusetts and New York. The greatest amount of annual rainfall seems to be about the highest of the White Mountains. It is set down at fifty-five inches, but the rainfall for 1876 was seventy-eight inches. It is probable that fifty-five inches is none too high for the average. The next largest is in central New Hampshire and southern Vermont, being from forty-four to forty-six inches, shading northward in Vermont to thirty-eight, thirty-nine, and forty inches, while an area west of Lake Champlain has but thirty-seven inches.

In comparison with other places, this seems a small amount. The average annual rainfall in Calcutta is 118 inches. On the Amazon river, 500 inches. In Guadeloupe, 282 inches. In Singapore, 190 inches, and many other places equally large, but the general summary of observations throughout the world establishes the fact that within the tropics the average amount is about 100 inches; and the average number of rainy days eighty. In a belt, including the Southern States, seventy inches in one hundred and twenty-five rainy days. In a belt from the Southern States to northern Vermont, forty-five inches in one hundred and fifty-six stormy days, while the average fall in Siberia is only five and a half inches in two hundred stormy days. A small amount of rain if at proper intervals is sufficient for vegetation. Our amount of rainfall is as well calculated for production as that of any section of the globe. It much exceeds many sections of the fertile West, and is much more constant from year to year.

The following table shows the amount of annual, as well as monthly, rainfall at forty-three stations, most of them being for a series of years:

TABLE OF RAINFALL.

COMPILED FROM MANUSCRIPT RECORDS, SMITHSONIAN TABLES, AND OTHER AUTHENTIC SOURCES.

NAMES OF STATIONS.	Jan.	Feb.	March.	April	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Spring.	Sum'r.	Aut.	Win.	Annual Rain-fall.	REMARKS.
Barnet, Vt.....	1.85	3.85	3.20	2.06	4.70	4.75	4.50	3.50	2.59	6.50	2.75	1.00	9.96	12.75	11.75	6.79	41.16	Compiled from observations of 1869.
Bennington, "																	44.00	Monthly means could not be obtained.
Brandon, "	2.64	2.58	2.62	2.53	3.32	2.79	4.54	4.66	3.18	3.18	3.00	2.18	8.47	11.99	9.36	7.40	37.22	From years 1856 to 1869, from 1870 to 1874, give 38.29 in.
Burlington, "	1.26	2.19	3.05	4.69	2.46	2 84	4.18	3.51	4.71	3.76	2.72	2.41	10.10	10.53	11.14	5.86	37.63	Smithsonian tables give a little less rainfall.
Castleton, "	1.87	1.63	2.00	2.47	2.43	2.61	4.95	4.69	2.64	5.67	1.99	2.84	6.90	12.15	10.39	6.34	35.69	From 1869 to 1874. Earlier observations give 38.44.
Craftsbury, "	2.80	2.40	2.00	2.67	3.45	4.12	3.95	4.68	4.40	4.21	3.10	2.35	8.12	12.75	11.71	7.55	40.13	From 1857 to 1873. Smithsonian tables give 40.44.
Fayetteville, "	2.90	2.71	2.75	4.29	4.70	4.66	5.00	4.12	3.37	3.18	3.67	2.60	11.74	13.78	10.22	8.21	43.95	Smithsonian tables show a little more rain.
Ferrisburg, "	1.67	2.36	3.04	4.26	2.50	3.40	4.70	4.04	3.25	4.46	1.98	2.56	9.80	12.14	9.69	6.49	38.12	From 1873 and 1874.
Hyde Park, "	2.30	2.71	2.42	4.06	2.70	4.11	4.00	4.02	3.90	3.71	2.38	2.37	9.18	12.13	10.59	7.38	39.28	From 1874 and 1875.
Lunenburgh, "	3.22	2.09	3.17	3.99	4.27	2.52	3.48	3.87	4.12	8.84	3.37	4.15	10.53	9.87	11.33	9.46	41.19	From a series of twenty-nine years, 1848 to 1877.
Middlebury, "	2.19	2.81	2.46	2.86	3.66	2.95	3.22	3.39	4.41	3.90	2.96	2.40	8.98	9.56	11 27	7.40	37.21	From 1864 to 1870. Average since that date, 37.98.
Montpelier, "																	39.18	No monthly means attainable.
Newport, "	3.20	3.00	2.85	2.75	4.18	2.68	3.70	4.15	3.92	2.70	2.50	3.70	9.78	10.53	9.12	9.90	39.33	From March, 1871 to 1872, also 1875 to 1877.
Norwich, "	2.80	2.76	2.80	3.12	3.43	3.80	3.50	3.80	3.25	4.00	3.40	3.38	9.35	11.10	10.65	8.94	40.04	From 1873 to 1876, also Smithsonian tables.
Randolph, "	2.78	2.91	2.75	2.28	3.37	3.41	3.35	3.90	3.40	4.58	3.31	2.47	8.40	10.66	11.29	8.16	38.51	Reduced from eight years' observations.
Rutland, "	3.50	2.78	3.10	3.01	4.72	3.91	2.31	2.38	3.01	3.63	4.10	3.49	10.83	8.60	10.74	9.77	39.94	For the year 1789. 1875 gives 41.20.
St. Johnsb'y, "	2.17	1.46	2.68	2.96	3.09	4.08	4.83	3.55	3.59	5.01	3.90	3.69	8.73	12.46	12.50	7.32	41.01	From 1859 to 1862.
Stowe, "																	39.34	Could not get monthly rainfall.
Springfield, "	4.54	2.37	8.40	3.59	3.53	4.03	5.15	4.13	2.70	3.94	3.02	2.75	10.52	13 31	9.66	9.66	43.15	From 1860 to 1864.
Troy, "	2.21	2.08	3.42	3.69	2.37	2.65	5.85	4.38	2.67	3.84	2.60	3.68	9.48	12.38	9.11	7.97	39.44	Combined with observations at South Troy.
W. Charlotte,"	2.62	2.76	3.02	3.19	3.53	4.29	5.49	4.54	3.64	5.10	3.67	1.95	9.74	14.32	12.41	7.33	43.80	Seems too high for verification of stations near. Mean
Windsor, "	2.90	2 44	3.48	3.78	3.86	4.60	4.34	2.95	4.57	3.40	2.17	2.36	11.12	11.88	10.14	7.70	40.85	Compiled from different observers. [of six years.
Woodstock, "	3.11	2.77	2.62	2.94	3.54	3.18	4.48	3.29	3.40	5.36	2.76	3.03	9.10	10.95	11.52	8.91	40.48	From 1857 to 1874. Summary from eight years.
Ashland, N. H....	4.02	3.56	3.70	3.38	3.39	2.50	4.32	4.18	3.77	5.54	4.57	3.57	10.47	11.00	13.88	11.15	46 50	From January 1870 to 1874.
Bristol, " ..	3.84	3.58	4.38	3.41	3.03	3.02	5.12	3.50	3.55	5.51	3.84	3.30	10.82	11.64	12.90	10.72	46.08	From four years observation.
Claremont, " ..	2.96	3.26	4.99	3.32	3.96	2.93	3.94	4.92	3.51	4.15	2.38	3.37	12.27	11.79	10.04	9.59	43.69	From 1857 to 1868.
Concord, " ..	2.92	3.34	2.38	3.49	3.97	2.72	3.68	4.17	3.43	4.26	3.62	3.01	9.84	10.57	11.31	9.27	40.99	From 1849 to 1866.
Hanover, " ..	2.86	2.70	2.98	3.13	3.46	3.89	3.41	3.79	3.17	4.91	3.40	3.52	9.57	11.09	10.58	9.08	40.32	Reduced from 19 years observations at the College.
Lake Village, " ..	3.41	3.55	3.15	3.69	2.48	2.59	4.66	3.38	4.19	4.33	4.55	2 80	9.32	10,63	13.07	9.76	42.78	From January, 1870 to 1874.
Londonderry, " ..	3.69	3.93	2.47	4.56	5.53	2.33	2.07	4.89	2.07	5.26	5.01	3.86	12.50	9.29	12.34	11.48	45.61	From 1849 to 1868.
Manchester, " ..	2.74	3.94	2.07	4.78	4.83	1.94	2.86	8.33	3.84	3.68	4.06	4.10	11.68	11,13	11,58	10.78	45.17	From 1852 to 1861.
Meredith, " ..	3.38	3.08	3.08	4.75	3.66	2.52	3 41	3.08	4.41	5.12	4.56	2.86	11.49	9.11	14.10	9.33	44.03	From 1868 to 1873, inclusive.
Mt. Washington, " ..	1.67	.29	.83	.07	4.62	18.46	3.59	6.33	9.58	6.10	3.52	.85	5.52	28.37	19.08	2.81	55.79	From U. S Signal Service, 1871 and 1872.
Portsmouth, " ..	3.39	2.47	2.94	1.01	3.02	2.72	2.20	3.41	1.99	3.76	2.29	1.58	6.07	8.33	8.04	7.44	29.88	Four years observation on sea coast.
Stratford, " ..	2.77	2.52	3.47	2.48	3.31	3.24	4.42	3.84	3.98	8.64	3.21	5.08	9.26	11.50	10.83	8.37	39.96	From 1856 to 1866.
Wiers, " ..	3.63	3.67	3.84	3.02	2.45	2.94	4.59	3.58	3.83	4.24	4.06	3.01	9.31	11.11	12.13	10.31	42.86	From 1868 to 1873.
Wolfeborough, " ..	3.53	2.81	4.01	3.32	2.18	2.67	4.85	3.84	2.45	4.20	3.66	2.44	9.57	11.36	10.31	8.78	39.96	Same time as Wiers.
Fort Miller, N. Y....	2.71	1.78	2.37	2.83	4.21	4.26	5.57	2.86	5.64	3.51	3.95	3.05	9.41	12.68	13.10	7.54	42.78	Four years,
Lansingburg, " ...																	42.89	Monthly means and length of time not sent me.
Plattsburg, " ...	1.25	2.30	3.49	4.20	3.30	5.67	4.04	3.33	2.90	2.80	2.93	1.80	10.99	13.04	8.03	5.35	37.41	Three years combined for result.
Troy, " ...																	43.07	Record lost, so no monthly means.
Amherst, Mass.....	3.89	2.21	2.28	3.97	4.13	4.27	4.48	5.86	3.18	4.21	2.83	4.59	10.38	14.61	10.17	10.69	45.85	From 1868 to 1876.
Florida, "																	44.08	Monthly means not received.

Diagram 1 shows the fluctuations in the annual rainfall in the Atlantic States,—Maine to Maryland,—from 1805 to 1867. It will be noticed that there are groups of years of unusual amount of rain, followed by years of drouth; showing that one follows the other with something like regularity. As a whole it seems the amount of rainfall is increasing. The figures at the left are the percentage of the mean amount.

Diagram 2 shows the fluctuations in the annual rainfall at Lunenburgh, and also shows the same groups of years. It is never certain that a large amount of rainfall precludes the possibility of droughts, as it may not be well distributed through the year. The year 1871 was remarkable for its dry summer, yet the amount of rainfall is above the average.

Diagram 3 shows the fluctuations in the annual snowfall at same place. The difference is much greater than the difference in rainfall. The greatest amount, 167.5 inches, is more than twice as much as the mean, which is 83.1 inches, and the least amount is less than half the mean, being only forty-one inches. Still the grouping of winters is observable as in rainfall, yet shows no time where there was over three consecutive years above the mean amount.

Diagram 4 shows the annual fluctuations of rainfall at Lake Village, N. H., from 1857 to 1873. It will be noticed that while the grouping is seen, that it is not as marked, or the fluctuation as great, as in Connecticut river valley at Lunenburgh.

TEMPERATURE.

As the sun's rays are perpendicular at the equator, and strike at a regular increasing angle as we approach the poles, it would seem evident that there would be an equally decreasing degree of temperature, yet such is not the case. We find that latitude is by no means a sure criterion of heat and cold. The equator should thus be the warmest section of earth, but such is not the case, the warmest place on either continent being about ten degrees north of the real equator. Also the cold at the poles, not as might be expected at the poles themselves, but about fifteen degrees from them, and beyond that impenetrable ice barrier is open sea. Again the lines of temperature are by no means regular. England, six or eight degrees farther north than we are, has a climate warmer than New York city. And Quebec, on the St. Lawrence, has as cold a winter as the interior of Siberia; while Canada West, in higher latitude, is as warm as Massachusetts, and the winter is full six weeks shorter than at Quebec. Still the summer at Quebec is as warm as the summer of Italy, where snow never falls. Thus we see how the lay of the land, and the currents of air and of water effect climate quite as much as latitude. In a hilly State like Vermont the streams of cold in the winter are nearly as regular as the streams of water in the summer. The air in contact with the earth becomes colder, and for that reason heavier, and so flows down our valleys like streams of water. In the Connecticut river valley runs down a great stream of cold air, making quite regular temperature in winter the whole length of the State, and bending the annual temperature lines at least fifty miles further south in that valley than on the hills. I give a table extending through three years, from observations at Woodstock and Lunenburgh. These tables show that

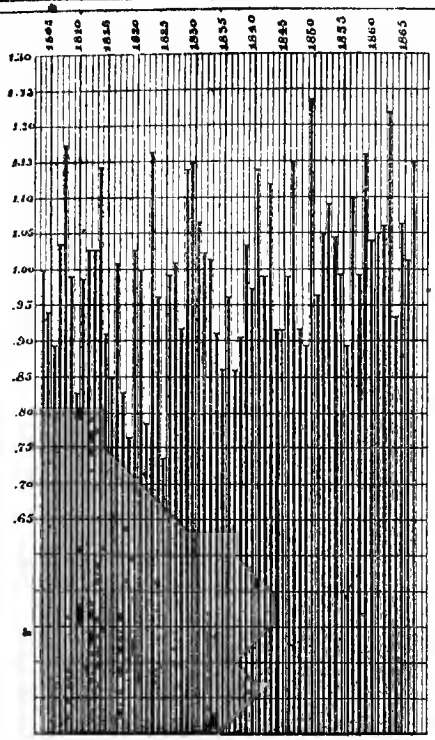


DIAGRAM I.

Fluctuations in Annual Rainfall on the Atlantic Sea-coast, Maine to Maryland; from Smithsonian Rain Table, by C. A. Schott.

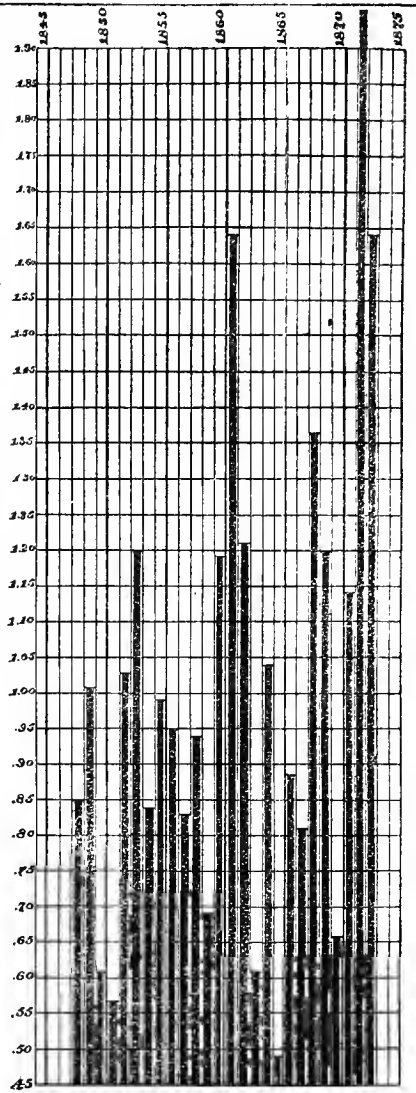


DIAGRAM III.

Fluctuations in Snowfall of the Upper Connecticut Valley; from Observations by H. A. Cutting, M.D., Lunenburg, Vt.

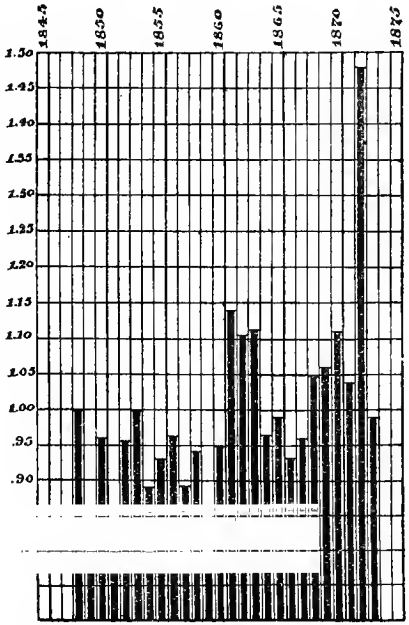


DIAGRAM II.

Fluctuations in Annual Rainfall of the Upper Connecticut Valley; from Observations by H. A. Cutting, M.D., Lunenburg, Vt.

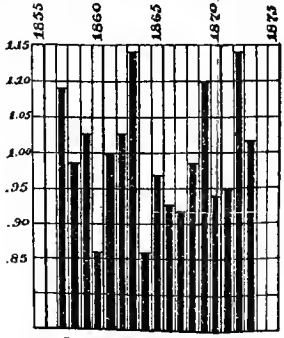


DIAGRAM IV.

Fluctuations in Annual Rainfall at Lake Village; from Observations by the Winnipisseogee Lake Company.

there is no great variation between them. Woodstock is 650 feet above tide water, and the place of observation in Lunenburgh is 1,210 feet above, being six hundred feet higher than the Connecticut river valley. The table also gives comparative rainfall. It is several degrees colder in winter in the river valley, two miles from my station, than here.

TABLES OF MONTHLY SNOW AND RAINFALL, MONTHLY MEAN, MAXIMUM, AND MINIMUM TEMPERATURES.

COMPILED FROM THE SMITHSONIAN AND OBSERVATIONS BY MYSELF.

1868.

		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
WOODSTOCK, VT.	Snow,—inches	.35	4.	.17	22.	1.	.....	.....	.....	.....	4.	16.	25.
	Rain, or melt. snow	3.50	.04	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Date	3	21	27	16	29	18	13	3 19 26	13	8	1	21
	Thermom., max.	49	45	53	70	77	87.5	95	84	80	73	56	38.5
	Date	13	8	1	10	4	3	27	17	18	24	24	25
	Thermom., min.	—20	—33	—28	—2.5	28	35	46	39	27	10.5	12	—27
	Mean	13.58	10.29	17.74	36.79	52.41	63.11	71.81	64.17	53.76	39.49	29.86	14.47
LUNENBURG, VT.	Snow,—inches	18.75	14.50	13.	5.50	.....	.....	.....	.....	.....	.....	.....	.....
	Rain, or melt. snow	1.87	1.45	1.50	1.30	4.50	4.40	4.62	1.81	3.08	1.30	7.15	2.45
	Date	2	20	31	16	28	18	13, 15	3	12	7	1	21
	Thermom., max	33	37	57	68	77	87	75	85	80	65	54	32
	Date	18	24	1	10	9	3	23	17, 28	18	30	17, 30	27
	Thermom., min.	—16	—27	—12	4	32	36	53	49	25	15	14	—30
	Mean	12.2	8.78	27.93	34.	52.48	62.15	71.58	66.73	54.58	41.6	29.60	13.82

1869.

WOODSTOCK, VT.	Snow,—inches	22.	40.	26.	2.	5.	.....	.....	.....	.....	1.50	6.	14.30
	Rain, or melt. snow	.....	.....	.....	.....	.....	2.85	1.76	2.24	3.44	12.90	2.29	2.94
	Date	8	13	27	27	12	4	25	20	7, 8, 20	14	4	1
	Thermom., max.	50	50,5	53	66	85	84	86	88	82	73	59	53
	Date	23	8	1	11	1	7	6	8	23	28	26	8
	Thermom., min.	—25.5	—21	—28	17	23	32	40	35	31	18	7	—18
	Mean	19.08	19.37	17.74	39.71	52.51	59.84	65.22	61.59	59.12	41.86	30.	22.44
LUNENBURG, VT.	Snow,—inches	18.	36.	19.5	3.	1.	.....	.....	.....	.....	3.5	2.50	7.75
	Rain, or melt. snow	1.95	3.67	2.5	1.75	2.75	5.	2.75	2.50	2.60	7.72	2.	2.25
	Date	13, 19	13	28	20	31	4	11	25	17	1	5	1
	Thermom., max.	35	39	47	61	78	84	84	78	82	72	56	40
	Date	8	8	2	5	1, 4	6	1	31	28	28	26	8
	Thermom., min.	—20	—12	—23	20	34	46	52	48	36	21	13	—12
	Mean	14.73	19.80	19.43	38.25	53.88	60.93	67.58	63.43	61.60	42.90	30.53	21.93

1870.

WOODSTOCK, VT.	Snow,—inches	25.39	36.50	24.50	3.50	.....	.....	.....	.....	.....	4.	2.	26.75
	Rain, or melt. snow	6.20	5.12	2.60	3.27	1.81	5.35	1.82	1.03	4.93	3.30	1.87	2.51
	Date	23	12, 18	30	28	16	25	24	9	1, 2	16	9	23
	Thermom., max.	52	45	57	78	83.5	91.5	90	91.5	85	70	61	51.5
	Date	14	5	4	1	6	23	2	27	13	27	16	21
	Thermom., min.	—5	—14	—8	18	29.5	49	43	34	31.5	17	15	27
	Mean	23.60	16.07	23.66	42.04	54.05	68.04	70.10	85.61	57.01	45.71	34.17	16.49
LUNENBURG, VT.	Snow,—inches	23.05	40.	17.25	.....	.....	.....	.....	.....	.....	.50	9.	8.
	Rain, or melt. snow	4.55	4.10	4.52	2.50	4.00	3.5	4.55	6.42	3.	3.95	5.25	1.30
	Date	17	18	31	27	30, 31	29	24	9	4	12	9	2
	Thermom., max.	42	44	52	68	82	94	89	90	80	79	56	40
	Date	14	2	12	4	7	22	2	26	12	27	22	25
	Thermom., min.	—12	—13	—15	25	35	50	56	48	38	17	18	—18
	Mean	21.88	16.23	23.73	42.70	53.43	68.68	72.57	67.25	59.75	46.20	33.55	21.55

The following table shows temperature, rainfall, depth of snow, relative humidity, and height of barometer, for the past year, ending in June. This was a very dry season, and it will be noticed that the rainfall is much below the average:

Months.	Mean Barometer	Temperature.			Mean relative Humidity.	Total Rain and Melted Snow	Snow.
		Mean.	Max.	Min.			
1876.							
July	28.87	68.15	95	52	81.54	5.22	
August	28.92	65.48	90	44	88.67	1.25	
September	28.77	55.22	88	40	86.39	5.90	
October	28.59	40.28	68	20	90.41	1.60	1.00
November	28.81	34.33	55	10	88.64	1.67	4.50
December	28.57	12.00	38	—24	80.16	2.81	28.10
1877.							
January	28.34	9.78	41	—14	78.17	2.15	21.50
February	28.73	24.10	49	0	76.67	.65	5.00
March	28.70	27.70	54	5	75.98	6.40	9.00
April	28.81	42.40	72	27	81.28	2.35	0.50
May	28.12	52.49	79	34	77.58	1.05	
June	28.84	63.99	85	42	83.85	3.00	
Sums						34.08	69.60
Means	28.67	41.33				2.84	

As I have a more extensive series of observations than any other in the State, I add a table for twenty-nine years, showing average temperature, monthly and annually, also amount of rain and snow. The rainfall for this period ranges from 33.50 to 60.91 inches, and the snowfall from 41 to 167.50 inches. There is also, as will be seen, much variation in annual temperature.

METEOROLOGICAL TABLE.

Observations made at Lunenburgh, Vermont.

Latitude, 44 deg. 28 min. Lon. 71 deg. 41 min. Elevation, 1210 feet.

Year.	Average monthly Temperature in degrees and hundredths.												Yearly means.	Rain & melted Snow.	Winters.	Snow in Inches.
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.				
1848	19.50	17.00	30.40	41.30	50.00	67.65	70.30	69.25	58.50	44.50	26.00	20.40	42.90	41.00	-1849	71.00
1849	10.70	14.50	30.00	40.50	53.70	58.90	69.60	54.75	56.40	40.90	30.40	19.50	39.99	35.80	1849-50	84.00
1850	10.00	14.07	25.50	35.00	55.00	69.50	67.60	64.00	58.30	50.00	29.73	21.00	41.64	40.00	1850-51	52.00
1851	20.50	14.22	31.75	39.16	57.00	62.50	64.25	70.00	51.50	40.00	25.80	19.00	41.31	33.50	1851-52	48.00
1852	20.50	19.28	21.00	32.00	50 50	64.50	69.00	65.50	58.00	43.00	30.00	21.00	41.19	39.00	1852-53	86.00
1853	22.00	12.70	23.50	38.00	54.00	63.50	69.75	67.00	56.50	43.50	28.70	23.75	41.91	41.75	1853-54	100.00
1854	10.60	9.00	22.34	34.16	52.30	67.10	70.40	64.50	57.25	45.75	32.30	15.26	40.07	36.60	1854-55	70.00
1855	21.70	14.30	29.20	39.60	40.80	62.70	67.20	68.26	60.00	43.75	30.00	21.00	41.63	38.25	1855-56	83.50
1866	22.00	18.50	20.40	35.50	51.30	67.40	68.50	64.00	57.70	44.00	28.90	20.00	41.51	39.80	1856-57	79.00
1857	14.20	20.00	24.50	32 70	50.60	65.30	60.80	62.30	62.00	42.50	31.00	19.50	39.62	37.26	1857-58	69.00
1858	8.30	23.10	24.70	34.60	60.00	59.15	65.30	62.40	63.00	42.50	33.40	21.50	39.88	38.50	1858-59	78.00
1859	17.75	19.00	25.50	38.00	51.50	63.00	64.50	67.00	57.00	39.50	34.00	14.00	40.48	35.30	1859-60	68.00
1860	18.20	16.00	28.50	38.00	58.50	66.50	69.00	66.00	56.50	49.00	39.00	19.00	43.60	38.90	1860-61	99.00
1861	19.50	22.00	27.00	41.50	48.50	63.25	68.00	66.00	54.00	45.00	32.00	21.00	42.31	47.00	1861-62	147.00
1862	16.00	19.50	26.50	39.00	55.00	63.00	68.00	62.00	59.50	48.00	30.00	20.00	42.21	45.80	1862-63	101.00
1863	24.00	19.00	19.20	36.10	59.20	64.30	70.20	70.00	66.00	47.00	26.70	18.40	42.51	46.00	1863-64	51.00
1864	18.00	20.60	31.00	41.00	55.00	68.20	71.90	70.90	55.88	48.10	33.86	22.56	44.75	39.02	1864-65	87.00
1865	14.80	19.06	33.80	40.97	49.21	67.30	60.84	70.82	56.65	37.42	34.56	24.46	42.48	39.69	1865-66	41.00
1866	14 45	20.35	27.50	37.98	46.10	69.00	73.25	60.90	62.37	48.68	45.72	20.91	43.02	38.10	1866-67	73.00
1867	9.62	23 52	24.61	39.10	49.34	65.97	70.06	64.83	49.37	44.93	30.05	10.90	40.19	39.65	1867-68	68.00
1868	11.69	8.87	28.46	34.61	53.04	63.65	72.07	67.26	54.98	41.49	29.55	14.86	40.04	43.37	1868-69	114.00
1869	19.27	20.00	19.67	38.80	51.91	61.78	68.19	63.83	62.07	43.30	30.53	22.08	41.78	43.95	1869-70	100.00
1870	27 08	16.31	23.89	43.31	54.08	69.12	72.67	67.63	60.42	46.69	3 .71	22.15	44.33	45.85	1870-71	55.00
1871	13.74	17.42	34.46	42.00	53.99	64.92	68.18	66.86	55.21	47.76	26.69	17.27	42.37	42.96	1871-72	95.00
1872	14.62	16.31	16.72	38.74	54.88	66.95	70.43	69.66	59.77	45.48	31.80	9.09	41.20	60.91	1872-73	167.50
1873	12.69	15.20	24.31	38.69	51.85	62.17	69.66	65.48	57.00	47.10	23.37	19.97	40.62	40.51	1873-74	117.00
1874	20 26	17.40	24.84	31.08	51.50	64.17	70.45	63.76	58.61	46.42	27.68	15.26	40.95	39.45	1874-75	127.00
1875	5.96	9.79	21.77	33.47	52.06	61.43	64.96	66.73	51.96	41.22	24.05	18.44	37.66	42.84	1875-76	102.50
1876	19.39	16.17	25.95	37.04	50.18	65.57	68.15	65.48	55.22	40.28	34.33	12.00	40.69	43.15	1876-77	70.00
Means	16.27	17.00	25.75	37.48	62.07	64.81	68.38	65.76	55.88	44.40	30.82	18.76	41.46	41.19		86.00

For this period the heat of summer has not exceeded 100 degrees, and but twice has the thermometer touched that point. It has once touched 45 degrees below zero. The extreme heat of summer rarely exceeds 90 degrees, and the cold of winter is seldom greater than 25 degrees below zero.

The average number of stormy days in a year for this period has been 120, and the average number of fair days 118, of cloudy days 127. From this it is reasonable to infer that our time is pretty equally divided into fair, cloudy, and stormy weather. In summer we have an excess of fair weather while in winter there is an excess of stormy or cloudy weather.

THE ATMOSPHERE.

It is desirable that all should have a general understanding of our atmosphere, and the laws by which our storms are regulated or produced, and to render such instructive I shall say something of the history of Meteorological Science, and also of familiar signs as well as instrumental observations. Two hundred and fifty years ago it was not known that we had an atmosphere. All the phenomena it produces were explained upon other principles, some of them showing the wildest theories and the most absurd ideas. The creation of the atmosphere as declared in Genesis, as the "firmament" dividing the waters, was not understood. A vague and unmeaning explanation was given it. When it was discovered that there was in reality an æriform fluid surrounding the earth, possessing weight, color, power of diffusing light and heat, and necessary to the existence of all animal and vegetable life, it struck with wonder and astonishment all the learned throughout the world. So wonderful and incredible did it at first appear, that it was not until after the lapse of several years, till opinions which had prevailed for ages were overthrown, and the most decisive experiments had been performed in every possible way, that it was cordially received. This atmosphere is composed mainly of two gases, nitrogen and oxygen. It was, however, less than eighty years ago, supposed to be a simple body, but is now known to be composed of about eighty parts by measure of nitrogen, and twenty parts of oxygen. It may be necessary to offer a few remarks on these gases, opposite in their nature; entering into no chemical union, yet being combined in so exact proportion as to support animal and vegetable life, and the smallest change, perhaps, detrimental to either. Oxygen gas is eminently the supporter of combustion, and ignited substances burn in it with the most intense brilliancy. Even shavings of zinc and iron may be ignited, by dipping the ends in melted brimstone, and introducing them into this gas while the brimstone is on fire. They then burn with intense heat and give a peculiar light, exemplifying the fact that if our globe was surrounded by an increased amount of oxygen, many now incombustible substances could he burned.

Nitrogen gas is exactly opposite in quality. It will extinguish fire as well as water, and will soon kill any animal that breathes it uncombined with oxygen. Yet four fifths of the air we breathe is this noxious substance.

Oxygen is the life-giving element, and as this is largely consumed

in combustion and respiration, and by those processes replaced by an equal volume of carbonic acid, which is detrimental to animal life, it would seem that the atmosphere would at length become deleterious. This would be the case, were it not for vegetation, which by aid of the sun's rays, absorbs the carbonic acid, and gives off, after the appropriation of the carbon, oxygen for the animal. Thus the animal and vegetable mutually support each other; I say support, as breathing affords three fourths of our own nourishment; leaving the other quarter, only, to be supplied by food. With this unceasing metamorphosis in beings and things, goes on a continuous exchange, by virtue of which the gases of the atmosphere take up their abode in animal and plant. Each atom of air, therefore, passes from life to life as it escapes from death after death, being in turn wind, flood, animal, plant, or flower, being successively employed in the composition of thousands of plants and animals.

It is the inexhaustible source from whence everything that lives draws much the largest share of its support, and into which everything that dies contributes. Under its action vegetables and animals are brought into existence and then perish.

Life and death are alike taken in at every respiration, and the atom of oxygen which escapes from the blade of grass may find its way into the lungs of the infant in the cradle; or the last sigh of a dying man go to nourish the brilliant petal of a flower.

WIND AND STORM.

We know wind is air in motion; this of course could not be known when it was not known that we had an atmosphere, so by the ancients entirely different causes were supposed to produce it.

Pliny, one of our greatest historians, being thoroughly reliable as regards the facts of his day, says, "In houses there be hollow places devised and made by men's hands for receipt of wind, which being enclosed with shade and darkness, gather their blasts." Thus in the time of the ancient Greeks; in the time of renowned men that invented an architecture, or manner of finish, which has been handed down and used to the present day, building their houses and their stately edifices, with curiously contrived cavities on the outside, as a resting place for wind. Wind to their minds was a spirit needing their protection, and one to which they did not wish to give offense. They supposed his abode to be in the mountains of the North which divided their country round about the Mediterranean, from the country of the fabled Hyperboreans, in the North, and that when displeased they hurled down the North wind, which was chilly and cold to the inhabitants of a more Southern clime.

Caves were places of superstitious dread, as they were supposed to be the resting places of wind, and finally became of use to the free-booters, as they were thus comparatively safe from the law. We learn from many ancient histories similar facts. The origin of wind as taught to their youth, and handed down to us in their ancient manuscript school books is this: "There be certain caves and holes in the earth which breed wind continually without end. They have wide mouths, and if you cast in anything of light weight, it will be seen presently to come out with a stormy tempest. Thus you can

see how all winds have a cause." That all winds have a cause we are ready to admit, but that they understood that cause no one can now believe. Even today we are in doubt about some of the causes of atmospheric disturbances. We know, however, that heat and electricity, as well as the revolution of the earth, and atmospheric tides, aid in the development of winds and storms.

Though all parts of the earth's surface have atmospheric currents of more or less force, there is great contrast in different sections. The Northern half of the Connecticut River valley, shut out by the White Mountains on the East from the oceanic currents, and by the Green Mountains on the West from the strong West winds of the continent, have aerial currents strictly local, and of mild force. The winds prevalent around Lake Champlain even, would be considered extraordinary gales here, while in many sections of our fertile West, the wind blows every day so as seriously to impede labor, while in many places peculiar winds and violent hurricanes pass, freqnently causing great inconvenience, and many times fearful loss of life and property. Though our quiet State is seldom visited by tornadoes, there has been a sufficient number to show that we are not exempt. Upon the 3d of July, 1842, there was a tornado in the town of Victory of remarkable force. Its devastations commenced upon the top of a high hill in that town, where its path was only a few rods wide, but it gradually increased to about half a mile in width, sweeping everything before it for about two miles, when it seemed to lose its power. Its track was a forest, yet it not only tore up the trees, but the soil also, piling it with the twisted and broken trees in huge rows near the place where its fury seemed spent. The noise of this tornado was heard for more than ten miles, and was supposed by many to be an earthquake. It was accompanied by heavy thunder and incessant lightning, with torrents of rain.

While tornados are rare, hail storms in some special sections of the State are of more frequent occurrence, and are usually electrical. But what electricity has to do with the formation of hail storms is not so clear. All we know of the nature of electricity is that it is a mighty force, called for the sake of convenience, a fluid. It appears to exist in every substance in nature, in both solids and fluids, and may be roused from its repose by a variety of causes, such as friction, heat, and chemical action. But we are totally ignorant of the reason why these causes excite it. When thus aroused it often displays tremendous power, and sometimes produces the most destructive effects.

In the formation of a thunder shower two or more clouds will first be seen, and seeming to attract each other, they approach within a certain distance, when their electricity begins to accumulate on the sides nearest each other. When this accumulation becomes sufficiently intense to overcome the resistance of the atmosphere, discharges take place, causing thunder and lightning. The same also frequently takes place between the clouds and the earth, in which case the lightning may pass both upward and downward.

The lightning is first seen, because light travels with immense velocity, while sound travels only 1142 feet per second. Thus it may be seen that if four and one half seconds intervene between the flash and the report, one mile intervenes between the discharge and the

observer. In this way the distance can always be ascertained unless the cloud is more than ten miles distant, in which case, in ordinary circumstances, no thunder will be heard. This sublime and terrific phenomena is well known to every individual, as it is occasionally displayed in every region of the globe. A thunder storm usually happens in calm weather, though they are sometimes accompanied with furious winds. The dust storms of Africa and India are also accompanied with much thunder and lightning. There is a peculiar circumstance sometimes attending thunder showers that converts them into hail-storms as before mentioned. The clouds in some cases seem to be very high, or carried up by the wind beneath, until, from their elevation, the water they contain may become frozen, and fall to the earth as hail. They are sometimes frozen very rapidly, the hail falling in all possible shapes, but generally the hail-stones are round or oblong in shape, and when broken open seem to be frozen round a snowy nucleus, frequently as well formed as a snow-flake, being star-shaped, like a large variety of our snow storms, showing that snow was first formed from a part of the water, every flake forming a nucleus for the formation of the water around it into a hail-stone. In other cases the hail seems to result from a purely electrical condition of the clouds, which in some way furnishes the cold necessary to freeze the rain drops.

The atmosphere aided by various disturbing powers resulting in wind, and its remarkable avidity for water known as evaporation; distributes moisture to the earth as dew or rain, rendering it fertile wherever this moisture is deposited. The most simple form of deposition is that of dew. This is the humidity of the atmosphere deposited on surfaces with which it comes in contact. During the day the solid portion of the earth becomes more heated than the atmosphere, and gives off moisture by evaporation. This continues to go on until the solid portion becomes cooler than the air, then this moisture is in part condensed on the solids, forming dew. Dew can be artificially formed at any hour of the day, as for instance: Take a pitcher of ice water, or cold spring water, and place it in the open air, or in a room in your dwelling, and the outside of the pitcher will in a short time become covered with drops of water. The general term given is that the pitcher sweats, and some even suppose that the water sweats through the pores of the pitcher. But such is not the case; it is dew, the same as deposited on the grass or ground, and from the same cause. Warm days and cool nights are favorable for large dews. I might almost say fair nights, for cloudy nights are always cooler, and sometimes, and in fact often, cool the atmosphere as fast as the earth cools, in which case there can be no dew. This shows an atmospheric change likely to be followed by rain. The atmosphere always contains more or less aqueous vapor in an invisible form. This vapor is water dissolved in it, in the same manner as refined sugar can be dissolved in water without changing its transparency. As warm water will dissolve more sugar than cold, so will a warm atmosphere dissolve more water, or in other words retain more vapor. If the temperature is depressed, the vapor appears in the form of clouds. If greatly cooled it will fall as rain, hail, or snow. This principle of evaporation and deposit of moisture now so generally un-

derstood and so thoroughly demonstrated, was once like all other points in meteorology considered as beyond comprehension; and attributed to supernatural causes. Horace speaks of dew as a gentle evening shower without clouds. Virgil says that every night we have a misty rain. Pliny, of the falling dew; and even at the present day how often do we hear the expressions about falling dew, showing that though we understand the principle and manner of deposit, we are not entirely free from the idiom of expression founded on the mythic reasons of past ages. Some countries are rendered productive and even fertile by dew alone, and doubtless this to the ancients being so mysterious, being deposited in greatest abundance when most wanted, and of vastly more importance to them than to us, caused them to regard it as an express gift of God, as the manna in the wilderness, by his hand, but not in accordance with the laws of nature. In the minds of those people it possessed wonderful virtues. It was supposed if man sipped the dew, and drank no other beverage he would possess new vital energies, and live on the earth a very long period, if not forever. Even up to the present time it is considered by some to beautify the complexion and restore the charms of youth. While by the alchemist of olden time it was supposed to be a solvent of mysterious power. In fine almost everything possible or impossible has been ascribed to its many virtues. In ancient philosophy it is described as the tears of the gods, and by all ancient nations as a gift from heaven. Thus we can see why, when the blessing of Isaac was conferred upon his son Jacob he used the expression, "God give thee of the dew of heaven." In the East it was much more abundant and important than with us, although of great importance here.

It begins usually to be deposited as soon as the sun goes down, and frequently before, and continues through the night. When the temperature decreases during the night to the freezing point, the dew is frozen, forming frost, its destructive powers being in proportion to the intensity of the cold. The glistening appearance on the surface of snow, are dewy particles frozen into beautiful prisms; when the sun shines upon them in the right direction they will reflect all the colors of the rainbow. Dew is deposited in all the fertile regions of the earth, but in sandy deserts, where the heat of the sun is so intense, the burning sands are never cool enough for its deposit. A desert is, therefore, not only a rainless tract, but a dewless one. This deposit not only varies greatly with the season, but in different sections much in amount.

The dew in this section amounts to about three and a half inches of water per annum. In Europe to about five.

Dew is, as we have seen, the most simple form of disseminated moisture, yet simple as it is, it is very efficient. Indeed, every shrub and herb, every leaf and blade of grass, possesses according to its wants a different power of radiation, so that each condenses as much dew as is necessary for its own individual wants. Thus not even a single dew drop seems to have been formed by the rude hand of chance, but it is adjusted by the balance of infinite wisdom to accomplish a definite and benevolent end.

CLOUDS.

The next means of disseminating moisture is by clouds. Their formation I have already explained. They are not vapor, as vapor is invisible, but water. Not held in solution, but in minute particles, supposed to be hollow globes, as fine as floating dust. In reality, water pulverized,—so light that they may be readily blown forward by winds, yet ready to be condensed and precipitated as rain by the slightest causes. This condensation is commonly produced by reduction of temperature, either by a cooler current of air or by electrical changes. Clouds are continually varying in their form and appearance, but may be classed under four heads.

THE CIRRUS

is a light fleecy cloud resembling a wisp of hair or bunch of feathers, and is the highest of all clouds. The water it contains is of course frozen into snowy particles on account of its great elevation; and further, we know it is so, as æronauts passing through it in their balloons always find it so, and its peculiar appearance is owing to that fact, as the wind blows the frozen particles about in long wavy lines. When this cloud is seen, if it be watched, it will gradually change into a sort of dappled sky or wavy cloud, and disappear, or else the length of the lines will increase and expand over the heavens; in this section the resolution into the mottled sky indicates fair weather, but the last mentioned form indicates a storm, which will be likely to come in three days or less. Still when we have had a storm, and those clouds are seen, it is a sure indication that the storm is about to abate, and for that reason they are termed by some fair weather clouds. Second,

THE CUMULUS

is the common cloud wafted about by the wind, sometimes piled up in the horizon so as to look like snow-capped mountains, or like ocean billows lashed with foam. If those clouds move off and appear high above the mountains, fair weather may be expected, but if the lower edges are smooth, and they hang around our mountains, look out for storms, for they then have to settle but a few feet nearer the earth to become rain clouds. In summer they produce many showers, especially when the weather is hot; as evaporation is rapid they increase in size, and sinking nearer the earth they discharge their contents with thunder and lightning. You can usually tell something of the state of the atmosphere and probabilities of a storm by watching a small cloud of this description. If it increases in size and assumes a darker tint, it indicates a storm; if, on the other hand, it decreases, it indicates fair weather, and if it be entirely dissipated no storm may be expected, but if dissipated rapidly look out for showers, as the electrical condition of the atmosphere is such that they may be produced as soon as evaporation supplies the requisite amount of moisture. Third,

THE STRATUS

is a horizontal misty cloud, frequently observed in a summer evening lying across the country, slightly elevated, and apparently having no

motion, also along rivers and over ponds where it is known as fog. It is usually dissipated by the sun in the early morning, but sometimes is in sufficient quantity to produce rain, but in this section is generally a fair weather cloud. Fourth,

THE NIMBUS

or rain cloud has a uniform gray color, has fringed edges when they are seen, but usually covers the entire sky, and the rapidity of the rain depends on its thickness. The nearer the ground the greater its probable thickness, and the more water contained within it. All know this cloud, in a moment, as it always produces rain. With us it is a common cloud, but in many sections of our globe it is never seen, as extensive tracts of land exist where rain never falls. Some of this land is rendered productive by the overflow of rivers like Egypt, others by copious dews like some parts of Arabia, but by far the larger portion of the rainless districts are barren deserts like Chili and Peru, or the great desert of Africa or Arabia. On the other hand within the tropics where the great cloud belt that continually encircles the earth swings gradually North and South, changing their seasons from wet to dry, there are places where rain and mist continually fall, but as those tracts are among islands or upon the ocean, they are of little account. The island of Tahiti forms a striking example, rising out of the tropical ocean to ten thousand feet above its surface, it forms a nucleus for the condensation of clouds, and the thickly wooded sides are well fitted for rapid evaporation by the hot winds of the ocean, so there goes on with great power rapid evaporation and incessant rain. The amount of rain which usually falls in Vermont, in a rainy day, is seldom over one inch, and generally much less, the entire fall of water including melted snow, is on an average about forty inches. We are, however, like other countries, liable to very great

IRREGULARITY OF STORMS,

and on some rare occasions as many as four inches have fallen in twenty-four hours, as on the 3d of October, 1869. With this exception we have not for twenty years had over two inches in twenty-four hours, and that only seven times during this period. These were all remarkable rains. As it takes a foot of snow to make an inch of water, you can see our winter storms are much less than those of summer. Of remarkable storms I will notice, at Catskill, N. Y., July 26th, 1819, eighteen inches of water fell in seven and a half hours, making a flood which swept everything before it. Great numbers of cattle and many buildings shared the devastation. Whole forests were uprooted and floated away. In California, July, 1862, thirty-two inches fell in twelve hours. Thongh this was only the case in a small section of country, the ruin was almost without precedent. Large brick buildings were carried away so the least trace of them could not be found, old beds of rivers were filled up and new formed, and devastation was the order of the day. This, in fine, was only one of three floods that has visited that country since it became a part of the United States. At Genoa, Oct. 25th, 1865, thirty-four inches of rain fell in twelve hours, causing general destruction of property. These

floods in temperate zones are rare visitations, but not so in the torrid, as hardly a single day passes but what a tornado, or deluge, takes place on some limited portion of that section. Sometimes as many as thirty-five inches of water fall in eight or nine hours, as was the case in the Cuban tornado of 1867, which swept away almost everything on the island, reducing the inhabitants to a state of starvation, donations being sent out from New York and other cities for the thousands of sufferers. Many instances are recorded of fish, frogs, and a great variety of animal and vegetable substances, falling from the clouds.

These are sometimes taken up by waterspouts and whirlwinds, and in countries where those are prevalent are of no rare occurrence. Again, substances resembling flesh form in the atmosphere, as in the Kentucky meat shower of 1876, which was this peculiar substance. Or like the vegetable manna that fell in Russia in 1817, in sufficient quantities to afford food for cattle, and even for man, and form an article of traffic. Between twenty and thirty showers of blood are recorded in history, but when this blood has been examined by scientists, it has been found to be red earth mixed in the rain drops, and of course cannot be unusual where the bare red earth covered with soil impregnated with iron, is exposed to violent winds, capable of raising the fine particles to be brought to earth in raindrops.

Showers of sulphur, so often recorded, are almost always the yellow pollen of the birch or pine. But we will leave these curious freaks of nature, and look more particularly to our own climate.

The Smithsonian Institute, with a corps of observers throughout the world, endeavored to establish a theory by which coming storms could be predicted. Though they failed in accomplishing all they hoped to do, yet it became evident that by a series of observations taken in different sections, by competent observers, much might be gained, and by telegraphing such observations to a central point the progress of storms could be known; and the telegraph could convey in advance the probable force and effect of coming storms. It was at once seen that such an arrangement would greatly benefit the shipping off our coasts, and the agriculturists of our country; and the War department in connection with the Postoffice department, organized a service for the purpose of conveying such information over the country for the benefit of all. Though the appropriations have been entirely inadequate for the work, much has been accomplished and millions of dollars saved.

As I have before stated, most of our storms commence far south or west. We frequently receive notice from the Signal Service, stating that such a storm is coming, when the heavens are unclouded, and nothing but a slight decline in the barometer indicates its approach. Many of those storms expend their fury before reaching us, and a cloudy day only will show their previous existence.

HOW TO FORETELL STORMS.

To the agriculturalist the ability to foretell, even for a day, the approach of a storm, is many times of great advantage. I much regret that all are not able to derive that knowledge from the Signal Service reports, but as such cannot be at present, I will explain the uses of

such instruments as will aid in forming a reliable conclusion as to the probabilities, many times amounting to an absolute certainty, of a coming storm, and then mention the reliable signs, without instruments, which my observations have established as worthy of note.

First, it is necessary to ascertain the amount of water held either by saturation or clouds in the atmosphere. If the atmosphere in this latitude is thoroughly saturated, it may contain about eight inches of water, all invisible to the general observer, yet with such a degree of saturation the heavenly bodies will appear somewhat dimly, and as water is a much better conductor of sounds than air, sounds will be more readily transmitted. People will notice the difference, and call it the sign of a storm. It shows a fact, that is, that a large amount of moisture is contained in the atmosphere. But as without instruments the amount of moisture must become a Yankee guess, it will not answer for the scientific observer. He must have something more tangible.

With the common uses of the thermometer all are acquainted. At first thought it would seem impossible that the thermometer could be used to show the exact amount of moisture, as well as heat, in our atmosphere, yet such is the case. If we hang two thermometers side by side, they will indicate the same temperature; but if we cover the bulb of one with fibres of silk, and saturate it with water, we shall find that the evaporation of the water will produce a greater degree of cold, and that thermometer will fall, sometimes as much as 8° or 10°. Now it is found that when the thermometers stand several degrees apart that the atmosphere is very dry, and consequently evaporation rapid; but as it becomes saturated, and evaporation less rapid, the thermometers will more nearly coincide, and when evaporation can go on no longer, the atmosphere containing all the moisture it can, they will then be exactly alike; but of course rain must be imminent. This instrument when put up in proper form, with tube to contain water to keep the bulb of one thermometer constantly wet, is called a psychrometer, and is an important instrument to the meteorological observer.

Tables have been constructed so that the exact amount of moisture contained in the atmosphere can, in connection with this instrument, be always known; but as a large amount of moisture may be long retained unless there is some decided change, we have to look to the barometer for guidance. With this instrument there is one general direction, which if allowed to have full scope would obviate many difficulties. That is, the rise of the mercury from any point denotes less wind, and a general improvement in the atmosphere, with less inclination to storm. A fall from any point indicates wind and storm, or a condition of the atmosphere more favorable to such. But as wind, rain or snow affect the barometer in the same manner, how are we to prognosticate which will take place? Here we receive aid from the psychrometer. If, when the fall takes place, the atmosphere is fully saturated with moisture, of a necessity this moisture will, in part at least, be condensed and fall; if, on the other hand, the atmosphere contains but little moisture, wind only will result, yet the fall may be equally great. By this you will see that those two instruments go hand in hand if you would form a good judgment. Yet to the per-

son possessing only a barometer, I would say that a due reference to the direction of the wind, the formation of the clouds, and the temperature of the atmosphere, will give sufficient data upon which to predicate a reliable opinion.

SIGNS OF RAIN; VISIBLE AND INVISIBLE.

A hunter ere the sun dispels the fog of a mucky morn, builds his camp-fire in the forest. The stifling smoke arises from damp and half decayed fagots. His culinary duties release the fragrant odors, from eggs and bacon, while frying onions still send forth their aroma, mingled with the sweet williams, violets and blue bells, at his feet. His dogs sniff the air, and from this medley of smells scent a fox, and start upon its trail, while another follows a rabbit. In this is a lesson for the thoughtful, humidity, smoke, stench and odors of a hundred kinds, arise and impregnate the atmosphere which previously occupied the whole space; and many contend that the relative gases in the atmosphere are unchanged. Then we have the anomaly of a vessel a hundred times full without once emptying. This also illustrates how the atmosphere may become, all invisible to us, the vehicle for the conveyance of moisture.

It has been ascertained by experiment that when the atmosphere is fully saturated, it may contain as much as thirteen grains of water to the cubic foot; all invisible to the naked eye, if at eighty-six degrees of temperature. Now, how shall we ascertain its presence? The barometer and psychrometer aid us but are not always at hand. Common observations have established in the minds of all certain signs of storm, which have in many cases a foundation in scientific fact. The following lines first published many years ago, and emanating from an unknown pen, embody many of those, and so I reproduce it as a text upon which I can offer explanations:

"The hollow winds begin to blow,
And the barometer is low.
The soot falls down, the spaniels sleep,
And spiders from their cobwebs peep.
Last night the sun went pale to bed,
The moon in halo hid her head.
The clouds look black appearing nigh,
And see, a rainbow spans the sky.
The walls are damp, the ditches smell,
Closed is the pink eyed pimpernel.
Hark how the chairs and tables crack,
Rheumatic joints are on the rack.
Loud quack the ducks, the sea fowl cry,
The distant hills are looking nigh.
How restless are the snorting swine,
The busy flies disturb the kine.
Low o'er the grass the swallow wings,
The cricket, too, how sharp he sings.
Puss on the hearth with velvet paws,
Sits wiping o'er her whiskered jaws.
The smoke from chimneys right ascends,
Then spreading back to earth it bends.
The wind unsteady, veers around,
Or, settling in the south is found,
Through the clear stream the fishes rise,
And nimbly catch the incautious flies.
The glow worms numerous, clear and bright,
Illumed the dewy hill last night.
At dusk the squalid toad was seen

Like quadruped, stalk on the green.
The whirling wind, the dust obeys
And in the rapid eddy plays.
The frog has changed his yellow vest,
And in a russet coat is dressed.
The sky is green, the air is still,
The mellow blackbird's voice is shrill.
The dog so altered in his taste,
Quits usual food on grass to feast.
Behold the crows, how odd their flight
They imitate the gliding kite,
And seem precipitate to fall,
As if they felt the piercing hall,
The tender colts on back do lie,
Nor heed the traveler passing by.
The rocks are seen in shade to sweat,
Although the sun is radiant yet.
In fiery red the sun doth rise.
Then wades through clouds to mount the skies.
'Twill surely rain, we see it with sorrow
'Twill rain today and rain tomorrow."

As the "hollow winds" are South winds, which are productive of moisture, and are likely to cause a depression in the atmospheric ocean, the barometer usually falls when they blow, and air of a cooler temperature coming from the North to fill up that depression, usually condenses the moisture, causing rain. The "soot falls down," as by the absorption of water from the overcharged atmosphere, it is loosened and crumbles off.

Spiders on the alert for food, build their webs to catch flies; and as their hunger, like that of flies and fishes, becomes more intense when a part of the atmospheric pressure is removed, they are very impatient for food, and so peep out from their hiding places. Who has not noticed spider webs in the fields flat, and also at different angles, and heard the remark that when flat they denoted fair weather, and otherwise foul weather. The spider, intent only upon his food for the ensuing day, spins his web with instinct, almost reason. A fine day is always preceded after midnight with perfect calm, and at this time the spider builds his web flat. If a change of weather is in progress, this calm does not exist, and a breeze is in its place. The spider, knowing that rain-drops break his web, if flat, builds it at an angle according to the amount of wind, so the rain-drops will not strike fairly and break it. They sometimes fast, not building at all when the storm is to be very violent.

Circles around the moon, or mock suns, known as sun dogs, show that there is a large amount of moisture in the higher atmosphere, and are always brightest upon the sides of the sun from whence the wind is blowing in the upper atmosphere. As an illustration, we reason from this phenomenon thus: It is winter, the sun dog is on the south side of the sun, or brightest on that side. It shows south wind with moisture, which indicates warmer weather, with rain or snow. If upon the north side, cold winds with a small amount of snow.

Rainbows are formed by reflection of the sun's rays from falling drops of rain. If it rains in the morning when the sun's rays should dissipate the clouds, if a fair day, it is quite likely to rain more or less all day. From this the saying so common,—

"A rainbow in the morning,
Sailors take warning;
A rainbow at night,
Sailors take delight,"

is as a general thing correct, showing foul weather if in the morning, and a pleasant night, and perhaps for the next day, if seen at night.

"The walls are damp, the ditches smell."

In fair weather the atmosphere is usually more dense and the barometer higher, which shows the atmospheric pressure is greater; the gases which escape from foul places, rise high above our organs of smell, as their specific gravity is nearly uniform, while before a storm the atmosphere is less dense; consequently, as the disagreeable gases are the same heft, they float within range of our organs of smell, or but little, if any, higher than our heads. Thus they show by smell, probable storm.

"Closed is the pink-eyed pimpernell."

There are five plants which have been observed from time immemorial as indications of weather changes. They are the dandelion, trefoil, pimpernell, chickweed, and Siberian thistle.

The down of the dandelion closes for bad weather, but expands upon the return of sunshine. The trefoil is observed in Europe to have swelled stalks before rain, and contracts its leaves before showers. The pimpernel, which I suppose is the *anagallis arvensis* of Linnæus, is found in this country, and in some States grows in old fields, and among grain, where I have heard it called "devil weed." It flowers all summer, and when found in the morning with its red flowers shut, it will be a foul day; when fully open, a fair day; partially so, doubtful weather. Chickweed, which is common the world over, is an excellent weather guide. When its flowers expand freely, no rain may be expected for some hours; if it continues open for twenty-four hours, no rain for days. Half open all the time, showery uncertain weather; closed, long continued rain. If the flowers of the Siberian thistle are open all night, rain the next day is probable.

As regards the effect on animal life, what the coming storms have to do with it, is not so clear; yet the weather prognostics derived from the animal kingdom are often more to be relied upon than many people imagine. The lassitude and indefinable anxiety of nervous individuals before a thunder storm, the shooting pains in old wounds or scars, the aching and pricking of chilblains and corns, the attacks of headache or rheumatism, when a considerable change of the weather is about to take place, entitle many sensitive persons to be called living barometers, and so with the animal kingdom. I am inclined to think that the changes in atmospheric pressure may have to do with it, as it certainly does with the appetites of fishes and insects. It is well understood that fish generally bite best before a storm, and it is then that fishermen are about. They bite the best, as they feel a peculiar hunger when the barometer is low, showing less pressure from our atmosphere, and that is usually before a storm.

It is the same with insects. It would seem that at such times they had extraordinary feelings of hunger. All have realized, more or less, their greediness before a storm.

"Low o'er the grass the swallow wings."

It is a well known fact in natural history that certain insects have an exact number of vibrations of the wing to the minute, and if they

fly at all it is in the same manner. When the barometer is high, the atmosphere near the surface of the earth is more dense, from the increased pressure, and such insects consequently fly as high or higher than our buildings. With less pressure, or a low barometer, they will rise but a few feet above the ground.

The swallows that feed upon these insects, which they catch upon the wing, fly at the height that their food flies, which, on account of their diminutive size do not attract our attention, while the swallows readily do. So even this sign has scientific fact for its basis.

Thus I might follow out line after line of the poem, showing its agreement with well known facts; but I should risk tiring your good nature in so doing, and as I have given you examples, will only add that the sweating of rocks, so called, being frequently supposed actual sweat, is only a deposit of dew; and when deposited from the atmosphere in the daytime, shows that there is a very large amount of water held in saturation, and a change is likely to occur, causing it to fall as rain.

Rain may be expected when the sun rises pale, or when, after setting, clouds ascend in the part of the sky from whence the wind blows. A red morning sky is usually followed by rain; a red evening sky, by fair weather. For twenty-five years the probabilities in these cases as true, have been as ten to one. This proves the old adage—

> "Evening red and morning gray,
> Will help the traveler on his way;
> But evening gray and morning red,
> Will bring down rain upon his head,"

was founded on fact. When the moon is pale in color, with horns blunt at first rising, the stars seeming large, dull and pale, with no perceptible twinkle, or if encompassed with a circle, it indicates an excess of moisture in the atmosphere, and probable rain. If mists are attracted by tops of hills or mountains after clear weather, expect rain in a day or two. In dry weather, if mists ascend from woodland or water, higher than usual in the morning, look out for immediate rain; but if such mists appear after sunset or before sunrise, it denotes fair and warmer weather the next day. If the rain commences an hour or two before sunrise, the clouds will probably be dissipated by the heat of the sun, and it will clear up before noon. If it commences an hour or two after sunrise, it will be likely to rain all day. A bright moon with sharp horns, or sharp definition if full, wind shifting North, a sky full of bright twinkling stars, small clouds at North and none at South, and perhaps appearing in heaps, denote colder weather. The same with clouds and winds shifting South, indicate warmer weather.

Whether a storm will clear off warm or cold is often a question of moment, and must be ascertained from experience and observation. From a long series of observations I would say that generally when the clouds break up so that we can catch glances of the cirrus cloud, if that is seen to move from the south or the southwest, the storm will clear off warm; if from the opposite direction, it will clear off cold. Again, if the surface winds wheel round from the south to the west, warm weather is indicated; if from the north to the west, it will be cooler. So in time of thunder showers, if they pass to the south of

us, the atmosphere will seem much cooler than if they pass to the north. Again, the waves of temperature approach regularly. The old adage, that one extreme follows another, is verified in fact; and we usually have gradually increasing cold followed by as regular an increase of temperature. This is more readily discernible in the winter season, as will be seen by every one who has a thermometer, and will take the trouble to look at it. It is during this season that we have the greatest atmospheric changes, sometimes even as great as 100° of temperature in twenty-four hours.

There is another class of signs which some believe in, that are merely superstitions, having no foundation in fact. The Hindoos have their rain gods, the South Sea Islanders their wind conjurers, and the negroes of Africa their rain doctors; and previously we had our weather Almanacs and our Herschel's weather tables, one just as good as the other. Not many years ago that celebrated Herschel's weather table, which Herschel never saw, was considered almost infallible, and Thomas' Almanac quite so; but all enlightened people, unless some whose age has outgrown science, discard them. For the last thirty years our storms have taken place without regard to moon's quarters. We have had 2,668 storms, divided as follows: at new moon, 660; first quarter, 664; full moon, 668; last quarter, 676. This shows very plainly that the moon has nothing to do with storms. If the generally received idea was true, what little difference there is goes directly against it. The truth is that the moon has so little, if any, influence upon the weather, that men have never found out which way it is; and I can say, without fear of contradiction, that rain and wind doctors, and Hindoo gods, have just as much to do with the weather as this weather table, and no more.

In snow storms the form of the flakes, if observed, will tell the probable amount of the storm. Without cuts a description of the shape would be useless, and I therefore ask all to observe for themselves. We see the intelligent laws of God displayed in the countless myriads of show-flakes in any snow storm, usually all alike, and all perfect. Being ice, yet falling with such fleecy lightness that it requires one foot of recently fallen snow to be equal to one inch of rain. We see different snow storms unlike in the form of flake, yet a large majority of them will be stars of six points, but there are more than one hundred different manners of forming them. Why they have six points instead of three, or five, no one can tell. That subtile substance which we call an electric fluid sometimes tinges those beautiful snow-flakes with light, rendering them distinct in the night, and shedding a faint, though certain, light around. Observation has led me to believe that electricity is in fact a part and parcel of all clouds, being necessary to their existence, and perhaps in a great degree aiding or preventing their formation. If so we must expect that snow clouds also share, and those beautiful tinted clouds of night, sometimes visible, appearing as part of the Aurora Borealis, may be, and I think many times are, the nucleus of coming storms. That the Aurora is in some way connected with our atmosphere, no one now doubts. That the same electricity which electrifies our storms produces it, is equally certain; then why may it not be instrumental in their production.

You will seldom see a brilliant display of the Aurora without a

storm soon following it. Could we but know a little more we could easily predict storms truthfully; but we must content ourselves with the intellect God has given us, and praise him that we are enabled to turn the lightning stroke from our dwellings, and harness the unknown principle of electricity, causing it to convey our words to the farthest points of earth, without delay. Yet we would fain know many things of our atmosphere, its currents and its aqueous meteors, which time will unfold. Should the next century bring with it as much science as the last, the farmer will not be at a loss today about the weather of tomorrow. Storms of intense thunder and lightning, with hail, will be avoided altogether, and many present wonders of the atmosphere will be understood. And the individual man will be gradually prepared for the nobler contemplation of the works of God, of whose greatness and goodness we can form no adequate conception.

Fig. 1. (Page 8.)

Fig. 2. (Page 8.)

Fig. 3. (Page 11.)

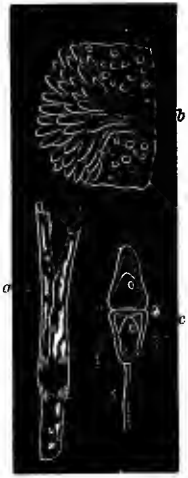


Fig. 4. (Page 12.)

Fig. 5. (Page 14.)

Fig. 6. (Page 16.)

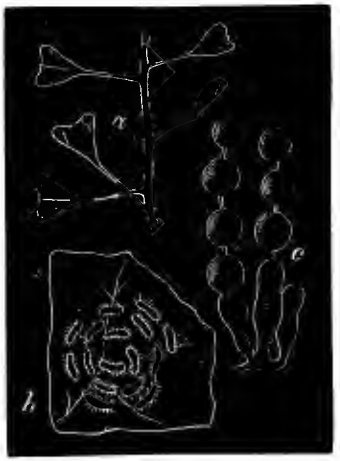
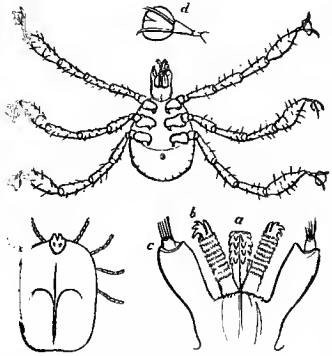


Fig. 8. (Page 21.)



Young *Ixodes alliciptus.*

Fig. 9 (Page 22.)

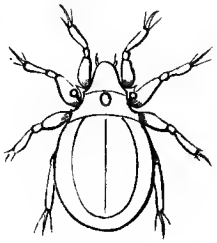


Fig. 11. (Page 23.)

Fig. 7. (Page 20.)

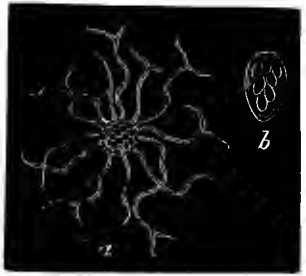


Fig. 10. (Page 22.)

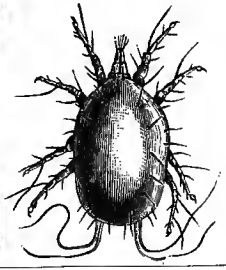
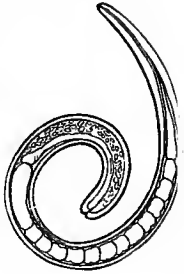


Fig. 12. (Page 26.)

Fig. 13. (Page 26.



MICROSCOPIC REVELATIONS:

FUNGI—Rust, Smut, Mildew and Mould.
ANIMALCULES—Water Mites, Sugar Mites, and Trichina Spiralis.

AN ADDRESS

DELIVERED AT ALBANY, VT., AT A MEETING OF

THE VERMONT BOARD OF AGRICULTURE.

ALSO, REPORT OF CONDITION OF

State Cabinet of Natural History

FOR

1877 AND 1878.

By HIRAM A. CUTTING, A. M., M. D.,
State Geologist and Curator.

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1878.

MICROSCOPIC REVELATIONS.

FUNGI AND ANIMALCULES.

BY DR. HIRAM A. CUTTING, STATE GEOLOGIST.

This address was delivered at Albany at one of the meetings of the Board, for the benefit of agriculture.*

At the present time, every one who possesses any love of nature, or even a love simply for marvelous things, desires some knowledge of the minute mysteries of nature. To follow out the peculiar character of animal or plant when too small singly for the human eye to study requires a microscope. At the prices they are now sold they are within reach of almost every person. With our microscope complete wherever we search, be it our own dwellings, the meadow or the upland, the grasses or the forest, the ruin crumbling into dust or the sands of the seashore, even in the waters of our marshes, rivers, lakes or ocean, there may be discovered plants and animals which are unknown to our unaided vision, yet endowed with organs perfectly adapted to their respective necessities; and with regard to the latter, often if not always for their enjoyment. Even in the aqueous vapor and dust of the atmosphere are germs of living beings, both animal and vegetable, though the latter much predominate, that the microscope alone enables us to contemplate with any satisfaction.

It is true that when near sundown a beam of sunlight struggles through the thick foliage of a forest, or enters our room by means of some small aperture, we can see floating in that beam of light, numerous particles of apparent dust, yet what its form, or its ultimate destination, our unaided eye could never inform us. It is the microscope alone that gives us aid, and that shows us countless spores, or seeds, to reproduce minute vegetation, as well as plants actually flourishing in the atmosphere. Also the germs of animal life are often, yes, very often there; and, judging from analogy, we find thus an easy method to propagate by germs various diseases in the human family; and that such is often true is beyond reasonable doubt, though such germs have never been fully identified. In our limited survey of those wonders of life and organization, which are thus revealed to us, it is natural to first turn our attention to the vegetable kingdom. And the largest number, as well as the most interesting, of the peculiar plants thus revealed in all their beauty; yet perhaps the most difficult to understand, on account of their varied appearance, and intermediate forms, are the

*This lecture was illustrated by over 100 colored drawings representing the various stages of the Fungi and animalcules, each being nearly two by three feet in size.

FUNGI.

Their sudden appearance and growth, their ephemeral nature, and the multiplicity of their forms, have always been a source of trouble to investigators, and even the most indefatigable of modern mycologists have been able to lift but partially the veil which hangs over the life and development of these organisms. Almost everyone, however, supposes that there can be no doubt as to what a toadstool, a mildew, or a mould is; and some may even correctly call them fungi, but many others are entirely unacquainted with that Latin word which denotes them. Rust on grain, and smut on Indian corn and other cereals, are also familiar to farmers; but a vast multitude of other all too numerous fungi are known only to the botanist by name, and only to the mycologist in their habits and structures, and to him only after long and patient study. In fact, it is to the researches of many eminent men and women, in Europe, Great Britain, and in this country, both among the dead as well as among the living, that the structure, habits and mode of growth, relation to the various departments of industry, injurious effects and general utility of these smaller fungi in nature, are collected and known. As plants, although of a low order of organization, they are of great interest as mere objects of beauty; but to attain a full comprehension of this fact we must have recourse to the microscope, as the peculiar portions of these structures are beyond the reach of unaided vision. No one that has not had his eye upon them, aided by magnifying power, could possibly conceive that the little specks of brown or black, seen on the brilliant ripening foliage of the maple in September, and October, or on the skins of apples, pears, and other fruit; on the dry stalks of plants or straw, on old decaying matter, on the buildings and fence rails, on the panes of the window, or the bodies of diseased insects, like bees and house flies; in fine, on almost everything; are receptacles of exquisitely sculptured and carved seed vessels, called *spores;* often beaded thread-like strings of pearls; again, consisting of myriads of the most fantastic shapes, that the genius of man could imagine, but could never imitate.

A subject so broad and so varied; one which can be investigated at any season of the year, inviting the naturalist, more especially the botanist forth, from earliest spring to latest autumn, to search for forms of beauty on every living or ripening leaf and fruit, and in winter, rendering the evening lamp more attractive in studying the collected treasures of the summer's gleanings; even if such collections have not been made, the barn with its harvested treasures is at hand, and from that may be taken specimens which can never fail to interest as well as instruct every thoughtful person in some way or other; and would ever be of the greatest interest, if presented in an agreeable manner, and shown with regard to their reference, or connection, with the industrial pursuits of society.

Not only is such study of interest to the botanist, whose speciality is the study of fungi, but it possesses more than ordinary interest to the husbandman whose crops often lie at the mercy of some of this class of parasites, and to his family, as their welfare often depends upon these minute organisms. Even a slight acquaintance with a few of these wonderful little plants, would render the walk for exercise

or pleasure ten times more valuable, and often remunerative. Who even without special thought upon the subject has not noticed along the roadside early as June, where blackberry bushes are found among weeds and grass, that their leaves were powdered underneath with rich golden dust, which might be shaken from little orange cups? Many times from children, and often also from the middle aged and old, has come the query as to what it was. On other bushes also, when yielding fruit, even, to tempt women, men, boys and maidens; yet would they turn aside, because the dust was ominous, but in what way or from whence it came none knew.

Those dusty looking lilac bushes, so dusty ere the close of summer that no rain could wash them clean, nor ever will, so long as that peculiar white egg-mould riots on the upper surfaces of their leaves.

The crystalline drops of permanent dew, on some refuse matter, often attract attention as they glisten in the sun, but few stop to examine and see the white threads in countless numbers that permeate them. Though such things often attract attention, they are soon forgotten when we know nothing about them, and no one is there to tell an anecdote from their history. Cunningly, wisely and full of secret hidden meaning, a thousand forms of lower vegetable life look up into our faces, while we, with repressed curiosity and not quite willing, tread them under our feet. How few even ever stop to think that they are leaves in the great book of nature, and consequently worthy the reading, and that to every one who will study those pages and translate the hieroglyphics, that the time and trouble of deciphering would be richly rewarded by the knowledge obtained.

"How thankful I am to you," said a friend, "that you have told me so much about the lichens in our pastures. They are now a great source of happiness to me; formerly I detested them."

"The best lectures on botany," said a well known and highly appreciated educator, "are lessons upon every plant we meet." Yes, within reach of all of us is study for a lifetime, and we may thus not only please ourselves, but by and by be considered benefactors. With an intention to introduce a few of these little parasitical growths to the attention of the reader, and to make plain and easy what at first seems so obscure and mysterious, I will bring forward some of the more common species, and explaining by word and figure their form and habits, endeavor to interest you to such an extent that you will be willing at least to acknowledge their power for good or evil, and know where to find your enemy, when pet plants, or fields of grain, grasses or potatoes, are likely to fail under the evil so widespread and fatal.

CLUSTER CUPS.

M. C. Cooke, the great English writer on fungi, divides them into six families. In one of these families the spores are the principal feature. This family is called the "dust fungi" (*Coniomycetes*). Of course it contains many groups, called families or orders, which are analogous to the natural orders of flowering plants. Without enumerating any of the various characteristics of these orders, I will select one typical plant. The spores are enclosed in a distinct peridium (covering for the seeds). This is a cup-shaped excrescence on the infested leaves. This order is called *Æcidiacei*. They are al-

ways developed on living plants, sometimes on the flowers, fruit, or stems, but usually on the leaves; occasionally on the upper surface, but almost always on the under side of the leaf.

The different species are distributed widely over the entire world. They may be found on every continent, and on almost every island. When examined they look like minute cups upon the leaf, and hence we call them "cluster cups." Besides the generic name they have also added a specific name, generally derived from some plant they are known to infest, but this must not lead the student to suppose that one species is only found on that particular plant, for most of them infest many plants, yet some of course to a greater extent than others.

We must therefore look to the actual differences in the fungi, not in the plants they infest.

The leaf may be truly said to be the lung of the plant. Through the stomata (minute holes) on the under side of the leaf, the plant obtains nourishment from the atmosphere, which is as necessary to them as our breath is to us.

Anything that clogs or injures the stomata of any plant directly injures the growth of that plant. This little fungi, when the plant has become infested, breaks through the epidermis, destroying many of the breathing spores (stomata), and also draws its own nourishment from the life juices of the plant it infests. Before it breaks through the under surface of the leaf, the infested leaf if closely examined, will appear to be covered with little elevations or pustules, paler at the apex; these soon become ruptured, and the fungus pushes its head through the opening, at the same time bursting by radiating fissures. The teeth thus formed resemble those of the peristome of some mosses. All around the orifice the teeth, or fringe, becomes recurved, and the orange spores, (fungi seed,) are exposed, crowded together within. At first, and in fact while contained in the peridium (cup), these spores are connected together as a string of beads, but when dispersed they are scattered singly about the orifice, often mixed with colorless cells arising from the partial breaking up of the teeth, or fringe, of the peridium. Let us now for a moment examine the manner in which these cups are distributed upon the leaf. They are scattered without any apparent order over the under surface, with now and then one upon the upper surface, but they nowhere touch each other, unless at the margins of the leaf, but then they are never joined, only crowded. Generally there is a space greater than the width of the cups between them. The leaf is not thickened by their growth, and the upper surface gives you no indication of what is going on beneath. If a leaf be taken fresh, and the epidermis from the under side be stripped off, as it is often easy to do, the orifices through which the fungi have burst will appear in irregular holes, and the fungi will be left rooted still upon the leaf, showing that they are not confined to the surface, and thus we see why the damage is so great to the plant upon which they subsist.

The spores in this species are orange in color, but variable both in size and form, though the majority are comparatively large. Each of these spores is capable of reproducing its species, and if we compute two thousand cluster cups as occurring on each leaf, and many leaves have double this number, and supposing each cup to

contain two hundred and fifty thousand spores, which again is much below the actual number, then we shall have not less than five hundred millions of reproductive bodies on one infested leaf, to furnish a crop of parasites for the plants of the succeeding year. As we thus so soon reckon by millions, our figures and capacities fail in appreciating the myriads of spores which compose the orange dust produced from one infected cluster of plants. Nor is this all, for it is found that one of these spores is not only capable of producing a plant, but is in itself a bundle of vegetative spores, which are exceedingly minute, and yet small as they are, they have the capability to produce fresh crops of cluster cups.

Naturally enough, our reader will ere this be debating in his own mind how these spores, which we have seen are shed in such profusion, can enter the tissues of the plants which give subsequent evidence of infection, as I have described. In fact, how the yellow dust with which the atmosphere may be filled today can inoculate the young plants of next year. If one or two of these spores are sprinkled upon the cuticle which has been removed from the leaf, as we have before indicated, it will be seen that they are very much larger than the stomata, or breathing pores, which stud the cuticle; hence it is clear they cannot gain admittance there. There remains but one other portal to the interior of the plant, and that is through the extremities of the roots. Here another difficulty arises; for the spores are as large as the cells through which they would there have to pass. This difficulty is however much lessened when we remember that these spores are a bundle of infinite particles, each particle of which is probably capable of infesting a plant. Even under this consideration, there is much need of an active imagination, to invent hypotheses, to cover the points upon which we as yet know nothing definite.

"The Rev. M. J. Berkeley, proved many years ago that the spores of bunt, for example, may be caused to infect all the plants the seeds of which had been placed in contact with them." But this did not prove that the seeds absorbed them, as it is probable they did not, but they would adhere to the seed and thus be conveyed to the ground, where infection to the sprout would be probable. Much has been done to elucidate this mystery, but much remains a mystery still. No spores have ever been seen traversing the tissues of growing plants.

The stems and leaves of violets, sweet-scented and scentless all alike, are often distorted and ruined altogether by a variety of cluster cups; the stinging nettle does not escape; the hardy dock, the useful currant, the wild geraniums, alike feed with their juices fungi of this description.

It has long been a popular belief in England, (says F. B. Hough in his report on Forestry,) that the barberry bush (*Berberis vulgaris*) has some agency in the propagation of rust in wheat and other grain, and the researches of botanists have somewhat tended to confirm this belief. The spores from grain rust (*Puccinia graminis*) are said to find their way to the leaves of the barberry, germinate, and form cluster cups on the under surface of the leaves, and the spores from these in turn germinate on the grain by alternate generation. The fact that rust sometimes appears in fields where there are no barberry

bushes capable of bearing the intermediate form, appears to indicate that there are other plants having the same capability of bearing the intermediate growth. The clearing off of barberry, or other plants or bushes, near wheat fields, has it is claimed been productive of good results; and if it should be proved beyond doubt that there is a direct relation between this and grain rust, the use of the barberry as a hedge plant, as well as that of other bushes, should be discontinued. Cook, on the other hand, says that while this statement long ago had credit among the people, it has no foundation in fact, as the genera are distinct and perfect in themselves; while some others, perhaps equally eminent, claim intermediate and spurious forms. Professor Œrsted, it is said, has recently determined their *identity* as one and the same plant. In this figure (fig. 1), *a* shows a leaf of the barberry, with cluster cups upon it (*Æcidium herberidis*); *b*, a portion of the leaf magnified; *c*, the same fragment seen sidewise.

Fig. 1.

The leaves of the pear show other species, and very singular and curious clusters of excrescences occur on the leaves of the apple tree and mountain ash, and are also very prominent on the leaves of the quince tree, and especially of the wild apple tree of the west, consisting of large peridia, pointed at the tops, and so swollen below as to bear a rude resemblance to urns, the edges split into long, contorted threads. They are a species of *Rœstelia*. The *R. lacerata* is seen in Fig. 2. *a*, natural size, living on the leaves and fruit of the hawthorn; *b*, a portion magnified. The spores are also of a light orange color, but the plant by comparison, or even by comparison of the cuts, may be seen to widely differ in its appearance. The fir and pine also suffer, as they are often attacked by the *Peridermium*, which changes the foliage, and spoils the effect of their branches, rendering them unsightly. Unfortunately but little is known of this fungus, but it is well worthy of attention from those that are interested in the minute aspects of nature, and those who can recognize the hand

Fig. 2.

"That sets a sun amidst the firmament,
Or moulds a dewdrop, and lights up its gem."

To this we can add our hearty assent, and only wish that investigation and studies so prolific of gratification were more universal, especially among the young.

But we must not stop for reflection, but slightly notice another class. The spores of the smaller fungi have thus far been spoken of as seeds, but this is not strictly true, and several novel and interesting points for consideration and inquiry arise.

If we should place some of the yellow dust, which fills the cup shaped peridia, in a drop of water, and prevent its evaporation by covering it with a watch crystal, or any other glass would do as well, we should find in a few hours that each particle of the dust had swollen, and bursting at some point had given out a little thread, at the apex of which it is crowned with delicate curved appendages, which soon become connected by lateral threads, thus forming a kind of latticed network, and from the sides of these filaments little cells sprout, which in turn germinate and reproduce the plant. Those of our readers who are familiar with the early stages of the ferns, can trace a striking analogy in the process.

In many of the smaller fungi the spore is present in another form, constituting what is termed the spermogone (pustules and depressions like pockets) often in shape of a minute dot near the peridium, and sometimes on the other side of the leaf. In fact it may be like a little blister filled with threads, throwing off little curved bodies called spermatia (germinating filaments), which escape through an orifice provided for the purpose.

Before the nature of these singular objects was known, spermagones were mistaken for distinct kinds of fungi, and many species were thus described. In the *Peridermium Pini* before spoken of they are white, few in number, and are developed not only in the spring, but sometimes reappear in the autumn upon the same leaves that produced them at the commencment of the year. The evident effort of nature, then, in this process, is to produce an ultimate condition of fungal life, which shall be sure to continue indefinitely the presence of the parasites upon the leaves and other parts of the higher plants. And this is done with certainty by the mycelium, a system of the most subtile threads, which can enter the tissues by attacking the seed when sown, and whose persistence of vitality enables it to endure the most trying circumstances unharmed. So vitalized indeed is the mycelium, that any fragment of it will vegetate and grow after long periods of desiccation. And its luxuriance of growth is in nowise dependent on any higher development, such as were it the stems and leaves of a flowering plant would be necessary to cause it sooner or later to push forth blossoms and fruit.

This wonderful vitality is taken advantage of in the cultivation of the edible fungi, such as the mushroom for example, where lumps of dry earth permeated by the mycelium, or "spawn," as it is called, are planted in prepared soil and a good crop realized. It is familiar to nurserymen, and all those who cultivate trees for shade or otherwise, that they often languish and die, owing to their roots reaching spots deep in the ground, where decayed wood or other vegetable remains are filled with this subtle fungal spawn, which inoculates the tree with the destructive fungus, causing its death. Fortunately the

awakening and full vigor depends much upon the atmospheric condition, else we should live in fear that every plant would be blasted. From this cause fungi of every form are often regarded as meteorological phenomena, and wet and foggy weather are complained of as harbingers of various fungoid evils.

MILDEW OR RUST.

Peculiar hot and damp days will be dreaded by nearly all on account of "mildew," but "mildew" is one of those loose terms that represents no definite idea, or a very different one to various individuals.

Talk of mildew of grain to a farmer, and he tells you of the rust which appears in lines or irregular spots upon the wheat stalk, indicating *Puccinia graminis*, which is known to him and generations before him in many sections as mildew.

Talk to a New England housewife of mildew, and she will describe a minute species of fungus which attacks damp linen, as true mildew, and will ask if you know what will remove the spots occasioned by it.

Ask the hop grower of New York about mildew, and he will point out a species of mould that infests the hop vine, but which differs as much from the mildew of the South as does the mildew of linen. The librarian will tell you of mildewed books and papers, and the housemaid of mildewed cellars, — all meaning a fungus growth, but as wide in their significance as the poison hemlock, and hemlock tree.

Mildew in England means in literature but one thing, and that is the rust upon wheat and other grain, known scientifically as *Puccinia graminis*.

But let us look into the history of this pest. In view of a clearer understanding of this peculiar pest, so long supposed to be several separate species, and which under the present light of science seems fast merging into one. We will suppose a fine day in June dawns upon our resolve to learn of mildew, or rust, and we stray away from the village to gain the chance to examine a wheat field. Having reached the field, there is no appearance of anything but a healthy crop; we walk into it perhaps fifteen or twenty yards before we find a single fungus of which we are in quest. But let us look closely down at the green leaves at the very bottom of the wheat plant, and we are soon rewarded, as we shall find one or two that look rusty. The surface seems powdered with red ochre, and to have grown sickly under the operation. Pluck it carefully, and examine it with low magnifying power; a pocket lens will do. Already the cuticle of the leaf is traversed with numerous longitudinal cracks or fissures, within which and around which you discern an orange powder, to which the rusty appearance on the leaf is due. Further examination reveals also portions in which the cuticle is distended into yellowish elongated pustules, not yet ruptured, and which is an earlier stage of this same disease. This is the Rust of the New England agriculturist, the *Trichobasis rubigo-vera* of the botanist, or the first phase of mildew.

To know more of this parasite we must take it to our microscope, and by careful manipulation we shall find that the vegetative system of this, as well of all similar fungi, consists of a number of delicate simple or branched threads, often intertwining and even uniting one to the other by little branchlets. These threads as we have before

explained are called the mycelium; they penetrate the intercellular spaces and insinuate themselves in a complete network among the cells of which the leaf or other diseased portion of the plant is composed. We may regard the whole mycelium of one pustule, or pore spot, as the vegetative system of one fungal plant. At first it might have originated as several individuals, which afterward become combined as one, for the production of fruit, and by their combined effort a cluster of fruit, or spore spot, is produced.

In the first instance a number of minute, transparent, colorless cellules are developed from the mycelium; these enlarge and are filled with an orange colored endochrome, and appear beneath the leaf as yellowish spots. As a consequence of this increase of bulk, the cuticle becomes distended in the form of a pustule over the yellow cellules, and at length, unable to withstand the pressure from beneath, ruptures in irregular, but more or less elongated fissures, and the yellow bodies which I will call spores, break from their short pedicels and escape; to the naked eye presenting the appearance of an orange powder.

On the first of August we will again visit our wheat field. Rusty leaves are more common than before. A little careful examination, and here and there we shall find a leaf or two with decidedly brown pustules intermixed with the rusty ones. If we remove from the browner spots a little of the powder by means of a sharp-pointed knife, and place it in a drop of water, and cover it with a thin glass, and place it under our microscope, a different series of forms will be observed. There will still be a portion of one-celled yellow spores, but the majority will be elongated, mostly with short stalks, and either decidedly two-celled or a tendency to be so.

These two-celled spores are another form of the mildew called *Puccinia graminis*, which may be produced in the same pustules and from the same mycelium as the rust previously described, and is generally considered at the present time to be the same fungus. Other grain and various other plants are likewise affected.

Fig. 3.

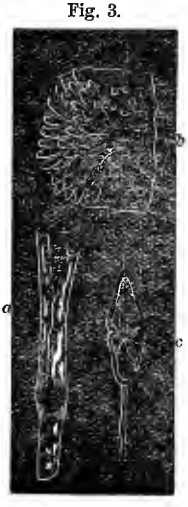


Fig. 3 represents at *a*, wheat straw infested with this rust; *b*, cluster of spores magnified; *c*, single spore magnified 300 diameters.

This rust is so common and so much alike on all plants that this plate will answer to represent the fungus wherever found.

Let us now for the third time visit our wheat field. It is ripe, or else much damaged, possibly destroyed by the fungi.

On the straw we shall find black lines, or blackish spots, from the size of a pin's head to an inch in length; this is the mildew, rust, or Puccinia—it matters not what name it is called, in full maturity, and when once seen it is never forgotten. Botanists may dispute about its intermediate stages;—may give it different names when found on other plants,—but it still remains the great pest of the husbandman. There are no lingering

doubts in the minds of the agriculturists, botanists, savans of science, or laborers, that the rust is not injurious, because the most casual observation shows it in the sickly condition of all plants affected through the season.

The manner of impregnation is unknown, or if known is in dispute. Some believe as the stomata or breathing pores of the plant are open in damp weather, that the infinitesimal germs enter these pores and gain a foothold, and push their rootlets into the cellular tissue of the plant. Others think they enter from the ground through the roots, and others still do not believe that they enter the plant at all, but that the seeds are poisoned by the touch of their spores. Be it as it may, we well know that it exists, and of course desire to have as little damage from it as possible. Observation has shown that rich land, or that manured by old manure, is much more likely to have the grain crop injured than land not so rich, or manured by green manure, or some of our fertilizers. This should teach care in the preparation of our land. Some claim that an admixture of sulphur in sowing, and others that if it is sifted on the leaves is a preventative. Careful experiments have shown all such remedies useless. Ashes are good to produce a healthy condition of the crop while they have no effect upon the fungi.

The state of the atmosphere conducive to very rapid growth, is usually liable to develop the pest. We believe that all straw infested to a large extent should be burned, and all grasses and weeds standing around such fields should share the same fate. In this way the principal danger might be avoided.

Another instance of the two-formed condition of the smaller fungi can be traced in the delicate condition of mouldiness which frequently covers the leaves of the lilac, the grape, the fruit of the gooseberry, and various other plants. It looks like strings of beads made of colorless cells. In this condition it is known and described as "Oidium."

Fig. 4. *a*, tufts of conida of the *Oidium Monilioides*; *b*, portion of grass leaf with same species of blight, the spores being the self-same beads and egg-shaped bodies, whence the generic name, but careful observation will show us that this is not its perfect condition; and when later in autumn these threads become more compact, and are surmounted on their horizontal surfaces by shining black capsules, or perithecia, each of which is filled with elegant elliptical and elongated cells, and each in turn containing several spores, we shall find in *Erisyphe* that we have arrived at the conclusion of the dimorphism of this fungus, so injurious in its effects.

Fig. 4.

The famous grape mildew so destructive to the grapes of Europe, and known as *Oidium Tuckeri*, is also only an imperfect form of some common *Erisyphe*; so of the grape fungi of New England, as well as of various other fungal plants.

Even the cluster cup first described, is quite likely to turn out but one form of the rust, on some other plant. Some, as I have before

said, even now suppose it identical with the puccinia, and with good reason.

SMUTS.

Another of the fungal diseases of grain, long and widely known among agriculturalists, is here called smut. Different names have been given it in different localities. In some it is "dust brand," in others, "bunt ear," black ball," etc. All the names refer to the blackish, sootlike dust with which the infested and abortive heads are covered. This fungus in New England does not generally excite much alarm among the farmers, yet it often injures the crop. Perhaps it is not so extensively injurious as rust, yet it destroys every infested head of grain upon which it establishes itself, and is also thought to be poisonous to people, or animals, that feed upon it. In Johnson's work on the grasses of Great Britain, he says "that diseased wheat examined by Sir H. Davy, when good, had an average of .955 parts of nutritive matter to the 1000: sometimes from disease, or smut, rust, or mildew, it was reduced as low as .210 in 1000." The consequence of using such diseased wheat for food would be a step towards starvation, even though no greater evil resulted. It is, however, well known to be highly prejudicial to health; and the higher standard of living among the poorer classes of our population, compared with those of some continental countries, is the only cause of their exemption from the dreadful diseases resulting from the use of bad grain. That such diseases might occasionally prevail among them here, from similar causes, under a more restricted diet, is evident from a record in the *Philosophical Transactions* for the year 1762. The case in question occurred in the village of Wallisham, about fifteen or sixteen miles from Bury, St. Edmond's, Suffolk, and the report of it was forwarded to the Royal Society by Dr. Wollaston, attested by the Rev. Mr. Bone, the curate of the parish, and is abridged as follows:—Some of the wheat belonging to a farmer in the neighborhood, being laid or beaten down by bad weather, and diseased, the grain much damaged in consequence, it was collected and threshed apart from the remainder. Being unfit for the market, it was sold at a low price to any of the farm laborers, and other people of the village, who would purchase. The sale of this wheat commenced about Christmas, and to one poor family, whose chief and possibly sole support it was for some time, the result was most alarming and unparalleled. It appears that the consumption of this poor wheat by the father, mother, and five children, was about two bushels in a fortnight; the same being eaten in the form of bread and puddings, both of them very indifferent in quality.

But to poverty, cheapness and sufficiency of food are always irresistible inducements, and this unwholesome fare was continued without intermission until the mother and her children were attacked within a few days of each other with a gangreneous disease. The first indication of the disease was intense pains in the lower limbs. It first occurred on the tenth of January, and was thought to be rheumatism, but when this pain subsided it was followed by numbness and insensibility of the parts which terminated in mortification. The condition of the family at the time Dr. Wollaston made his report to the society is here subjoined:

"Mary, the mother, aged forty. Right foot off at ancle; left leg mortified, a mere bone but not off.

"Elizabeth aged thirteen. Both legs off below the knee.

"Sarah aged ten years. One foot off at ancle.

"Robert aged eight. Both legs off below the knee.

"Edward aged four. Both feet off at ancles.

"An infant aged four months. Dead."

The father was not attacked until about a fortnight after his wife and children, and in a slighter degree. In his case the pain was confined to two fingers of his right hand, which turned blackish and withered. Another laboring man in the same parish, who had eaten of this bread, suffered from numbness in both his hands for upwards of a month. They were constantly cold, and his finger ends peeled; one thumb he says remains without any sensation.

In several instances where bread made from the same wheat was eaten in the farmer's own family, as well as by other persons, no prejudicial effects were noticed, probably in consequence of such bread being used only occasionally, and as an adjunct to other and more wholesome food. The nature of the disease with which the wheat was affected does not appear to have been fully ascertained, but the circumstances are well authenticated. It is of course possible that the want of proper nourishment in the wheat may have had a share to do with the disease; but smutty and mildewed grain has always been considered unhealthy to man, and many cases of disease in animals has often been traced to this cause.

With such examples before us, too great caution cannot be used regarding the use of grain and flour of suspicious character.

This fungi, like many of the others that infest our fields and gardens, belongs to the family in which the spores are the distinctive feature, and is regarded as fixed in the genus *Ustilago*, (or smut of grain), and the specific name *segetum*, (standing). So we have the name *Ustilago segetum*, or the smut of standing grain.

Another kind of smut known in this country is *Ustilago magdis*, (the maize smut). It is even more common than the other, as no cornfield is without more or less of it. It forms a peculiar thickened and abnormal growth, that is full of the characteristic black spores represented as magnified four hundred diameters in Figure 5.

Fig. 5.

The spores in this fungus are very numerous, simple, deeply serrated, springing from delicate threads or in closely-packed cells, ultimately breaking up into a powdery mass. A species of this smut affects some grasses slightly in this country, but in France it frequently affects grass to such an extent as to produce disastrous consequences on the hay makers, such as violent swellings of the head and face, with poisonous irritation over the whole system. Threshers are sometimes thus affected in this country, when at work on smutty oats, although not all are equally affected.

The spores of this species are so immense in number, that it would seem impossible to guard corn or other grain against its ravages, but it seems like others of this class—they are quite easily destroyed, and in that way are kept in check. They adhere to the grain in threshing, but if the grain is washed with clean water, and then with a solution

of Glauber's salts, and while still moist dusted with quicklime, these spores will be destroyed, and the rust spores also, and the crop will be improved, as the caustic soda is set free by the sulphuric acid of the salts combining with the lime, and converting it into sulphate of lime (plaster of paris) which is beneficial to the young sprout, while the caustic soda is fatal to the spores of rust and smut.

Other washes, as of chloride of lime, at the rate of one ounce to the gallon of water, or of aqua ammonia in same proportions, are probably also beneficial to kill the spores, and aid germination of the grain. Experience has also taught us that a wet season is much more prolific of fungi than a dry one; and thick-sown grain than thin-sown.

The direction of the wind when grain is sown is of no effect, notwithstanding old people many of them think that an east wind is deleterious.

THE ONION SMUT.

This fungus, called by Prof. C. C. Frost of Brattleboro, *Urocystis Cepulæ*, since its first appearance in New England in 1870 has caused much damage to that crop. It is thought to be allied to the rust on Indian corn, but not exactly the same. The damage caused to single towns in Massachusetts from this smut alone is estimated at several thousands of dollars. There is as yet very little known about the development of this fungus. It has never been known in Europe, and is supposed to originate from some of our wild species of onions, and of course is as yet but imperfectly known here. It changes the onion to the peculiar dark sooty powder so well known as smut, and the infested onions at once cease to grow, and though the black may often be peeled off apparently with one or two of the layers of the onion, they are not considered healthy, and great loss is entailed to those raising them. As the spores doubtless remain in the ground, and nothing put on the ground would be likely to eradicate them, the only known help is to change the locality, giving the onions ground on which they have not been previously raised, and using the onion bed for other purposes, or for such crops as the spores would not injure.

After a time, perhaps four or five years, the old beds might probably be again planted, as doubtless the spores would have lost their vitality.

As this smut at the present time is principally confined to Massachusetts and Connecticut, with a little care on our part, it will be a long time before Vermont will materially suffer from this fungi.

Should it appear among us it should be at once stamped out by burning over the land, and not trying to raise onions on it for at least four years, as a trial would not only be useless but would endanger whole townships by the increase of the spores.

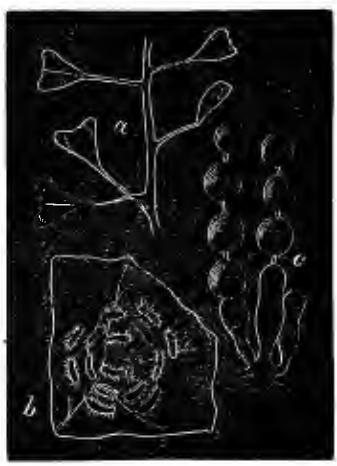
It should as much be the law to stamp out by legal proceedings such pests, as to keep small pox out of our towns, as the diseases resulting to the human family are none the less to be dreaded because slow and insidious in their workings.

Those who desire to know more of this disease we will refer to the Massachusetts Agricultural Report for 1876–7, where it is fully described.

WHITE RUST.

The idea we have thus far of rust and smut is that it is dark colored, or like the rust of iron, but as I speak of white rust that opinion must be overthrown, as the white rust of the cabbage, turnip, and all similar plants is one that the gardener has often to contend with. I bring it in to show that fungi must be looked for in every place and under all colors. This white rust is called *Cystopus candidus*. It is represented in Figure 6 as it occurs on shepherd's purse, *a* showing the fruit with the rust upon it; *b*, portions of the cabbage leaf with the same species upon it; and *c*, conidia of the same. (See Cook's treatise on Fungi.)

Fig. 6.



Upon the leaf of the cabbage it appears as engraved, in white patches; the leaves become deformed and swollen or blistered, even before we can make out fully the cause of the mischief outside. These blistered pustules have a minute system of branching threads, which traverse the pulpy parts of the leaves, and which threads insinuating themselves between the cells that constitute the pulp, take their nutriment at the expense of the growing foliage.

It is after the pustules assume the white color and are visible on the skin or cuticle that the reproductive parts termed conidia can be detected. *See figure 6.* From the multitudes of these beads or spores forming the white powdery dust, the term *conidia* is applied, which means dustlike. Other plants, besides, are often affected as the watercress, pepper grass, mustard, radish and even the weed purslane does not escape its ravages. Its mode of vegetation is one of peculiar interest, in fine one of the most curious phenomena of plant life, and indicates in this low order of vegetation a relation to higher structural forms, not only in plants but even in animals. Thus, if a few particles of the white dust be immersed in a drop of water, and examined under the microscope they will be seen to rapidly absorb water, and swelling, a large and obtuse papilla resembling the neck of a bottle is produced, and a seeming empty space is formed in the contents of each spore. As these disappear the whole granular substance becomes separated by fine lines into five to eight portions each, with a small, faintly colored, empty space in the center. These portions are so many zoospores. These are soon expelled one by one, and soon afterwards begin to move, being provided with seeming fins or fringes by which they are enabled to swim about like an animalcule: but they are only buds endowed with motion, same as many other plants have. These of course are capable of infecting plants, as we have seen.

The prodigal provision of nature is here, as everywhere, especially

in its lower orders signally manifested, when we are told that the immense number of zoospores capable of being produced from a single infested plant is almost beyond calculation. It is easy for a million of conidia to be developed from one such plant, each producing five to eight zoospores. It can scarcely be considered marvelous that the white rust should be so common on plants favorable to its development, the marvel being rather that any escape.

THE POTATO DISEASE.

Mould is a word in common use, and all will tell you what mould is, yet each will perhaps tell you of a different kind. This very numerous family are called *Hyphomycetes*, that is, fungi that grow by throwing out delicate threads.

Of course there are several distinct groups.

To the common eye, unaided by the microscope or observation, mildews, mouldiness, and similar microscopic plants, would be readily confounded. But the mildew is a much more highly developed fungus, and though apparently as dangerous, is not so to the same extent. The egg mould (Oidium) which covers and suffocates the young gooseberry, or the grape, readily yields to agents which will destroy it, and set free from its threads the swelling fruit; but the potato mould for instance, is the inception of the potato rot, which is so dreaded. The "moulds," then, as Russell says, "are fearful parasitic plants, which riot on the tender tissues of other plants and eventually cause their death." There is in this country as many as ten known fungi infesting the potato. It is on this account that those attempting to describe the potato disease have differed so widely from each other, while all have brought up some facts. The true potato mould, causing so much mischief, is now generally admitted to be the *Peronospora infestans*, and were it not for its effects it would be regarded as a thing of beauty. Were the flies or insects, which are so liberally endowed with eyes, and quite unconcerned about crops,—to investigate; the leaves of the potato would be quite a pretty set of objects to examine, presenting white, many branched, and beaded twigged plants, with egg-shaped seed bodies on the tips of the branches. These vegetable growths issue from the stomata (breathing pores) of the leaves, choke up the internal and external passages, and prevent a healthy, action from being maintained. Soon the leaves become paler, or yellow, then discolored spots appear, and the stems are covered with dark patches; even the stalks are filled with clotted substances, and sooner or later putrify, and lastly the tuber suffers, and the rot rapidly increases.

It was toward the close of the summer of 1845 that the world awakened to what they supposed a new disease in the potato crop; and one which threatened its entire destruction. Early in September its ravages in Ireland threatened starvation to the people. It extended to Scotland, England and the continent, and rewards were offered for detection of the cause, and a host of observations were made with no valuable results.

It is only by long years of patient study that nature's works are found out, and it will be longer still before any sure preventative will be reached. There are however some things that tempt this fungus

growth that is so destructive; as close planting, damp land, weeds that shade the crop, etc.

As there are some differences of opinion in relation to the actual condition of the potato, favorable or otherwise, to the rot, I copy from the observations of others.

"Some eminent chemists, such as Dr. Lyon Playfair, believe that the potato plant when healthy, is not subject to attacks from fungi. In a lecture delivered by the Doctor before the Royal Agricultural Society of England, December 9, 1845, he remarked that 'much had been said and written with regard to the source of the disease, and since minute fungi had been assigned as its cause, potatoes, apples, and other fruits had been inoculated with fungus spores, and had become diseased; but if there was not some previous disease in the potato itself, how was it that some varieties of potatoes escaped while growing in the immediate vicinity, while others were attacked?'" The disease, he believed, arose from structural or chemical causes.

When a decayed potato was examined it was found that the diseased spots were always in the region of the spiral vessels, whose function it is to carry air into the tissue of the plants. He believed the disease originated in the oxidation of the tissue. The Rev. M. J. Berkeley, the leading mycologist of England, on the other hand, contends that the fungus *Botrytis infestans*, or, as now classed under the new genus, *Peronospora infestans*, will attack the healthy tubers; but the question arises just at this point, what means have we of ascertaining the perfectly healthy structure, and chemical state of tubers. Every farmer plants what he deems sound tubers, yet in the majority of cases, since 1845, the crop during very moist seasons has been more generally affected than it was prior to that date.

The severity of attacks of fungi on plants will depend in some cases on the density of their organic structure and the solubility of their nitrogenous matter. The nitrogenous principle of potatoes, for example, is soluble in water, that of turnips nearly insoluble. The former, therefore, ferments more readily than the latter. The leaves of a healthy peach tree, when placed in a moist atmosphere at about 75° F., resist fungoid fermentation for months, while those of a peach tree affected with the "yellows," placed under the same general conditions, will quickly ferment and become covered with the fruit of the fungus mucor. The first possess an antiseptic property, the second are deficient in it. If two blocks of wood, one of boxwood and the other of soft pine, are placed in a fungoid solution, the first will resist the action of the mycelium for a long time because of its density, while the second will quickly decay. The first absorbs very little water, the second a great deal. A certain amount of moisture is always necessary to the growth of fungi. The presence of an excess of water is highly favorable to the growth of the common moulds and some other forms of fungoid plants.

In years previous to the noted potato rot of 1845, the average amount of water found in healthy potatoes, according to Professor Playfair, was 72 per cent.; that of unhealthy tubers since that date, 80 per cent. The tendency to ferment is therefore increased. It was observed by Professor Playfair, in his lecture alluded to, that a peculiar state of the weather had been observed all over the north of

Europe where the disease had been seen, as well as in America. The wide-spread use of the potato as an article of diet, especially among the laboring classes throughout Europe, must have led to the extensive planting of diseased potatoes in 1846, because healthy seed could not be found. Indeed, Professor Playfair, in his second lecture of the 10th of December, 1845, recommends "the planting of diseased potatoes as seed rather than none." He further states that there was no prospect of obtaining healthy seed from abroad, and that he had permission of the late government authorities for stating that this was the result of their consular returns. The unavoidable adoption of this advice tended to establish hereditary disease in after years, whether it arose from chemical, structural, or fungoid conditions.

If a healthy potato is so dug out on its opposite ends that it will resemble a double egg cup, and placed erect on one end for about six days in an atmosphere at the temperature of 70° F., its under cavity will become covered with mildew, and its fruit will appear in the form of blue mould, *Penicillium glaucum*. In this case the inverted cavity will retain the moisture, and as a consequence slight fermentation will ensue, the fungus deriving it nutriment from the potato; but the upper surface, although fully exposed to the floating germs in the atmosphere, will not sustain a fungus growth, in consequence of the free evaporation of the moisture from it. This form of fermentation should not be confounded with that produced by the fungus of potato rot, *Peronospora infestans*. The chemical action of the blue mould fungus is slow, and its odor is simply that of sour paste, while the destructive action of the potato rot is very rapid, producing a higher state of decomposition and very offensive odors. The mycelium and fruit of each fungus also differ essentially from each other. Both forms of fungus produce oxidation of the cellulose structure, but with very different results. Consequently potato rot consists of more than the "mere decay of the tissue by its absorption of oxygen." The purely fungoid theory, on the other hand, will not account for the many exceptions pointed out by those who favor the chemical theory; since it may be shown that as the chemical constitution and density of any vegetables vary, so will the genus and species of fungi be found to vary with the proximate principles of the plants on which they subsist."

If there is truth in these remarks, the value of sound, hearty seed is one great preventative. Farmers should therefore exercise great care in their selection, and never plant a diseased tuber. Yet to my mind the fungus is the chief mischief, and so plenty of room, good care, and I might add, early planting, should go hand in hand with the selection of seed. Russell says entire destruction by fire of all diseased tops should be imperative.

THE BRISTLE MOULD.

One more species of mould known as the "buttercup blight" is so common and so peculiar in its growth, that I cannot pass it by.

It is represented in Fig. 7.

a, conceptacle of *Erisyphe communis*; *b*, sporangium of the same highly magnified. Its varieties are all known as bristle mould, and attack damp paper or books; damp specimens in the collections of our botanists are frequently nearly ruined, and like other fungi they are dreaded pests.

Fig. 7.

RAPID GROWTH OF FUNGI: YEAST PLANT.

Yeast is a well known substance to all housekeepers, but all do not know that it is a plant that thrives on sugar or nitrogenous matter. When the plant is examined under the microscope it is found to be composed of myriads of minute cells, about $\frac{1}{2400}$ of an inch in diameter. During the progress of fermentation these cells rapidly increase in number, until all the material necessary to their growth is used up. Its rapid growth, and the evolution of carbonic acid gas, from such growth, makes it convenient for the housewife to raise her bread. She prepares her material, puts in her seed, which is some of the spores of the plant; either dry or in fluid, they immediately commence their growth.

The cells grow together in chains, and when stirred they sometimes appear like threads, which are in reality bundles of the fibers of the yeast plant.

If the yeast is not used in this condition, the plant nourishment is soon used up, putrefaction commences, and with it comes a swarm of animalcules, countless as they are minute, and voraciously devouring all in their way, until they also die from want of food, changing the yeast frequently to a mass of animal and vegetable putrefaction. This soon subsides and vinegar is the result.

This can be more fully exemplified by milk yeast, which sooner as every housewife knows, passes through its various stages, and sometimes is not baked until the putrescence is such as to be hardly endurable to many persons.

With this example of fungus growth before their eyes, who can wonder that the various fungi in the State of Vermont alone cost the agriculturist many millions of dollars. They blight his fruit trees from the seed; they blight his grain crop more or less every year; they blight his fruit from the blossom to its end, pursuing it with a determined hate; they mildew his beans and peas; they impair his corn and potatoes; they poison his hay, and disease his cattle; they destroy his loved ones, often with insidious disease, and then rot out his store houses, his dwelling, and even fastening upon himself, claim him at last as fit ground on which to ripen their spores for deadly work on others. No pest is so deadly, none so insidious in its workings, none so varied, meeting us everywhere and under almost all conditions. Insignificant in themselves, their very obscurity gives them the best chances to do us injury.

They have their enemies, countless animalcules feed upon their various forms, yet no family is rendered extinct. The very atmosphere we breathe is often hazy with the spores of various fungi. The

only wonder is, why anything, or any condition of plant or atmosphere can hold the various families of fungi in check. Some suppose them of spontaneous growth. Why is there need of such a supposition when their minute spores capable of producing their like cannot even be excluded wherever the atmosphere is present? The wonder is quite the other way, for it is a wonder that they don't destroy more than they do.

ANIMALCULES.

It is but a step from the microscopic plant to the animal. The variety of form peculiar to microscopic life is truly wonderful. It is so different from what we have been accustomed to meet in our visible world that we are at once struck with its peculiar varieties. The number of these creatures exceeds all human calculation. In every pond and ditch, and almost every puddle, in vegetable infusions, in paste and vinegar, on honey, sugar and all sweet substances, on almost every leaf and flower, even on those fungi only visible through the microscope, and in rivers, seas and oceans these creatures are found in such numbers and varieties as to almost exceed belief.

"The shapely limb and lubricated joint,
Within the small dimensions of a point,
Muscle and nerve, miraculously span
His mighty work, who speaks, and it is done,
The invisible in things scarce seen revealed
To whom an atom is an ample field."

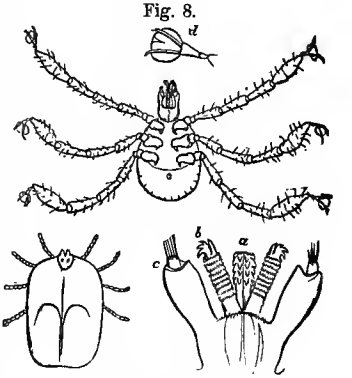
Of these wonderful creations I will only bring forward a few examples.

THE MITE FAMILY.

Comparatively few naturalists have studied up the habits and peculiarities of the mite family. But few of our readers in natural history text books, learn from their pages anything definite in relation to them, either regarding the affinities of these humble creatures, their organization and frequently singular metamorphosis. We shall therefore only mention a few typical forms which we have had the pleasure of examining.

Mites are lowly organized *Arachneds*. This order is divided into four families, viz: the Scorpions, Spiders, Harvestmen, and Mites; the scientific name of which is *Acarina*. They have a rounded oval body, without the usual division between the head and abdomen observable in spiders; the head, thorax, and abdomen being merged in a single mass. When mature, there are four pairs of legs, and the mouth part consists, as seen in the adjoining figure of a young tick, of a pair of maxillæ (*c*), which in the adult terminates in a two or three jointed feelers; a pair of mandibles (*b*), often covered with several rows of fine teeth, and ending in three or four larger hooks, and a serrated labium, (*a*).

Fig. 8.



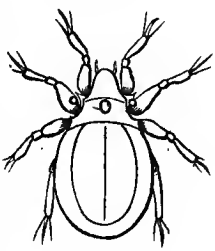
Young *Ixades albipictus*.

These parts form a beak which

the mite can insinuate into the flesh of its host, upon the blood of which many species subsist.

While very many of the mites are parasitic on animals, some devour eggs of insects. The *Notherus* (Fig. 9) destroys millions of the eggs of the canker worm, and it is said that it also sucks the eggs of the Chinch bug.

Fig. 9.



A few of this species are injurious to man, as the *Sarcoptes*, that burrows under the skin of filthy people, causing a disease once so common—the Itch. The cheese mites, that swarm over the cheeses in our cities, and sometimes in the country, have six legs when young, but eight after a moult. I have scraped a full pint of them off of a single cheese in Boston, and putting my hand into the mass I could distinctly feel the animal heat produced by aggregate millions of living, burning furnaces, the same as from higher organizations.

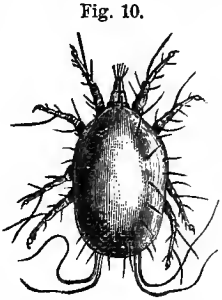
The Harvestmen, known in this section as "Daddy Longlegs," almost always have numerous parasites belonging to the mite family. They also live parasitic on various water insects, and on the gills of the fresh water mussel.

These species are very minute in size. Some species have been found in the lungs and blood vessels of various animals.

THE SUGAR MITE.

Many people have been startled by statements sometimes read, or that they have heard from authoritative sources, as to the immense number of mites, (*Acarus Sacchari*, Fig. 10,) found in unrefined or raw sugar, but those statements generally fall below rather than above the truth.

Fig. 10.



Dr. Hassel, who first discovered them, found them upon sixty-nine out of seventy-two samples, and found sixty or seventy mites to one grain of sugar, in most of the samples. Mr. Cameron counted five hundred on ten grains, which would be one hundred thousand to the lb. This would really be quite an adulteration, but under favorable circumstances, that is with warmth and moisture, I have seen one half the bulk, at least, animal life. This would, however, only be the case upon small lots of sugar. When in barrels their number is frequently immense, but they are much more plentiful at the top of the barrel, or nearest the light, though light is in no way necessary to their production.

The disease known as "grocer's itch," is undoubtedly due to the presence of this mite, which may now and then work its way under the skin of the hand.

Plentiful as these mites are on the damp brown sugars, I have never detected them on dry white sugar, though I almost always find them on figs, dates, honey, if grained, and often on the comb when

not; in fine they may be found on all sweet substances that are sufficiently exposed.

They are a jolly, playful race of beings, and seem to live and eat for enjoyment; when frightened they play dead, curling up their legs, and remaining inactive for some time.

Another singular mite, and of the lowest order, burrows in the skin of dogs, and also in the diseased follicles of the human face, and more especially the nose of man.

See Fig. 11.

Fig. 11.

It is a long slender wormlike form, with eight short legs, though like many other mites it has but six in the larval state. Washing the face in water to which has been added one teaspoonful of strong aqua ammonia to the quart will usually remove them.

WATER ANIMALCULES.

Perhaps no class of objects that are visible to us only through the microscope engage our attention so often, or amaze us so much, as the various forms and peculiar habits of the water animalcules.

For the first time it is an amazing spectacle to view an assemblage of dissimilar forms in a drop of stagnant water. They are from one thousanth to one ten thousanth of an inch in diameter, and I once saw them so crowded that the spaces between them were not much larger. Several hundred forms have been studied and described, but I shall only mention three or four of the more common species. Remember while pond or river water will contain now and then specimens, that it is stagnant water alone that is crowded, and the pure spring water of Vermont never contains any animal life.

The motions of these creatures are varied, I might say almost endless in variety, but amid their diversified gambols all have the power of avoiding obstacles in their course, and their neighbors, which are in such close proximity to them. Some species are far more common than others, but the more uncommon varieties may frequently be obtained in midsummer, by exposing a decoction of any dried leaves to the sun for three or four days; such exposure must be in the open air. A few species I will describe.

The *Rotifer*, or wheel-bearing animalcules, are so termed from the appearance of certain wheels, often seen rapidly rotating in various situations on the anterior part of the body near the mouth. We say wheels because they were so considered by early microscopic observers who could not account for the motion in any other way; but an improvement in instruments has shown that it is an incessant muscular action, giving an apparent rotation; but that wheels could revolve in any part of an animate body, would be quite inconsistent with the laws of animal organization. These wheel-shaped muscles are used to aid in the motion of the animalcule and in supplying its food. They are entirely subservient to the power of will, as they can stop the motion instantly or increase it as they choose.

Their body, though so small, in one species, is shielded by a shell into which this rotating apparatus can be drawn at will. It is by the whirlpool, formed by the before described rotations, that its food is drawn into its mouth as a vortex, where it is masticated by three tiny

teeth, and swallowed into a prepared receptacle where it is ground by muscles working vigorously on each other. Minute and curious as these organs are, the animalcule is so small that like all other microscopic creatures they are transparent, and with a moderately high magnifying power this can as well be seen as the workings of a steam engine made of glass.

This species enjoy sunshine, and on dark cloudy days are only found at the bottom of the pond or ditch in which they reside. Again another of this same species called *Tardigrade*, have so great a tenacity for life that they may be put upon a glass slide and dried for days, yes for months or years, and then at once resuscitated by a drop of water. Dr. Carpenter, one of the most renowned microscopists of Europe, states that their tenacity of life goes even further, as he has kept them in a vacuum for thirty days with sulphuric acid and chloride of calcium, thus causing them to suffer the most complete desiccation that the chemist can effect, and yet they have not lost their capability of revivification. For this reason they have been styled the resurrectionists, and it seems for good cause. This wonderful power of resuscitation, and the fact that the rapidity of their reproduction as estimated by Professor Erenberg, being from the egg at the rate of seventeen millions per month, is certainly sufficient for their remarkable appearance in almost every situation, and under almost all circumstances.

It has been supposed by some that they were the result of spontaneous production, but from what I have said you can see there is no necessity for such a conclusion. The many curiosities connected with the life and introduction of the Rotifer, into almost all places, of course will excite the amateur in microscopical investigation to search for them. That he may not be disappointed I will state that in the leaf cells of the Spagnum, generally known as Bog moss, there is a very curious departure from the ordinary type of vegetable growth. Instead of the usual cell tissue their leaves contain spiral fibres, loosely coiled in their interior, and in the membraneous covering of the stem, there are nicely rounded holes, or apertures, by which there is free communication with the interior, as well as with each other. These natural caverns are appropriated by the Rotifer, and used as dwellings.

It is here you are sure to find them at home.

Another species, called Aurelia, are covered with cilia, or minute hairs around the mouth in a circle; by their agitation animalcules much smaller are drawn into their mouths and devoured.

Again the Hydra, which may be found in ponds and rivulets adhering to the leaves of aquatic plants, or twigs and sticks that have fallen into the water, is a wonder among wonders.

It may be subdivided many times and yet every part will in a few hours become a perfect Hydra. This name is given them because they have many long arms, which were supposed to resemble the heads of the fifty-headed water serpent, called Hydra, which fabulous history informs us was destroyed by Hercules, in the lake of Lerna. They are by no means vegetarians, and have the capability of swallowing creatures as large as themselves.

In the ordinary mode of multiplication little budlike protuberances

are developed on their external surface, which are soon observed to resemble the parent in character, possessing a digestive sack and mouth.

For a time however this cavity is connected with that of the parent, but at last the communication is cut off, and the young Hydra quits its attachment and goes in quest of its own maintenance.

A second generation of buds are however frequently seen on the young before quitting its parent, and I have counted as many as eighteen in different stages of development on one original stock. Again in taking its food, it sometimes happens that the same morsel will be seized upon by two Hydra, when a struggle for the prey ensues, in which the strongest gains the victory. Sometimes each will begin to swallow the same morsel, until the mouths of the pair come in actual contact, when if the morsel does not break, the larger deliberately swallows his opponent, sometimes partially, so as to compel the discharge of the food by the smaller, but frequently the entire polyp is engulfed. But Hydra is no fit food for Hydra, and his capacity for endurance saves him from a living tomb, for after a time when the food is sucked out of his mouth, the sufferer is disgorged with no other loss than his dinner.

Yet perhaps the greatest curiosity is in the reproduction of its parts. Split one open and the separate parts will soon take food, and in twenty-four hours are as perfect as ever.

Strange as it may seem all these processes can be watched with unerring certainty, and so interesting are the developments, that I always dislike to close the scene, though aching eyes will at length gain the mastery.

TRICHINA SPIRALIS.

As the *Trichina Spiralis* is an animalcule liable to infest man to his injury, and often a disease of swine, rendering the pork dangerous to the consumer, I have selected it as of peculiar interest. It is a small spiral worm, like a pin worm, which has ever been found now and then in muscles of various animals. It is supposed by some to originate in the rat, and to have been from them spread over the country as they gained a foothold, as it is often found in their muscles, and frequently in those of cats that devour them. How it comes to infest pork is uncertain, but probably by their food, as a hog is none too particular upon what it feeds, and might eat portions of rats or any other dead animal.

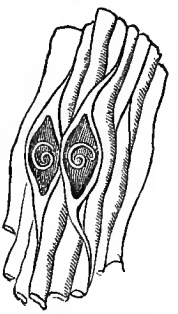
The immature parasites, as seen in muscle under the microscope, are worms about $\frac{1}{25}$ of an inch in length, spirally coiled up within globular, oval, or lemon-shaped transparent cysts, which, according to the length of time they have been formed, are more or less covered with calcareous matter.

From various experiments I have been led to believe that after they are completely covered with this calcareous concretion, sealed as it were in a stone sarcophagus, that they are destroyed; such flesh containing them will not contaminate other individuals, as I have fed young rats with it without effect, when they were always contaminated when fed with diseased meat, in which the cysts were not calcareous, though the cysts themselves are to be considered rather as abnormal-

ities, developed some little time after the larvæ have reached their destination, as hundreds of specimens have been seen to coexist entirely free from cysts.

Fig. 12 shows the Trichina when thus incysted in the muscles, (magnified).

Fig. 12.



The number found in any one subject varies, but Leuckart estimated that one ounce of cat flesh which he observed must have harbored more than 300,000 parasites. Even if we assume that the forty-five pounds of muscle which an ordinarily healthy man possesses were infested with only 50,000 Trichinæ to the ounce, they would still contain more than thirty millions.

Fig. 13.

The adult Trichina magnified is shown in Fig. 13.

The sexually mature male Trichina, according to Cobbold, is about $\frac{1}{18}$ of an inch long, while the adult female is $\frac{1}{8}$; the body is rounded and slender, and the head very narrow and sharply pointed. The mode of reproduction is viviparous. The muscular parasite, when introduced into the alimentary canal of man or animal, is set free in the process of digestion, and in two days' time reaches the adult condition. Leuckart states that in six days more the female brings forth a numerous brood of minute hairlike larvæ; these soon begin their wanderings by piercing the intestinal walls, after which they proceed through the system till they reach the muscles, into which they penetrate; here they develop so that in two weeks more, that is, in about three weeks from the time the infested food was taken, they present the appearance of the ordinary muscular *Trichina Spiralis*, as shown in Fig. 12.

The sexually mature worms probably produce more than one brood of young; they have been found alive in the intestines eight weeks after the injestion of the flesh in which they were contained. The larvæ remain in the muscles they have reached, and shortly become encysted as heretofore mentioned. Smoking the meat does not kill the parasites it contains; brine, if very strong and long applied, probably does; thorough cooking certainly does. Time also has its effect on them, though they are endowed with wonderful vitality. In some healthy subjects who died from accident, the larvæ and their inclosing cysts have been found to have undergone calcareous degeneration; but it is probably months, and even years, before death of the parasite occurs; in illustration of which, Virchow states that in one case he found them alive eight, and in another thirteen and a half years after infection.

When a person is infected, which infection usually takes place from eating partially cooked sausages or raw bacon, in three or four days there is lassitude, depression, sleeplessness, loss of appetite, and fever. Then there supervenes excessive pain in the muscles, especially of the limbs, contractions of the knee and elbow, swelling of the limbs with apparent pneumonia, and frequently mauia with death.

On postmortem examinations, the muscles are found crowded with the parasites, and to be in a state of fatty degeneration. If they recover, after three or four weeks of the same symptoms, with less severity, convalescence commences, and in six or eight weeks more the patient is quite well, and the encysted Trichinæ seem to give him no further trouble. The virulence of the attack seems to depend considerably on the number of parasites introduced into the patient's stomach, yet the previous constitution and strength of the patient, has much to do with final recovery.

The true safeguard is to eat no pork unless thoroughly cooked, yet microscopic examination will reveal the disease, even if ever so small a section of a muscle be examined, and it should be incumbent upon all butchers here, as in Germany, to make such examination, and they should be punished here, as there, for selling Trichinæous meat.

For this time I will present no further microscopic wonders. What I have said is sufficient to show you, that around us all exist immense fields of study, easy of access, and yet pregnant with wonderful facts, with but few of which we are as yet conversant.

> "Has any seen
> The mighty chain of beings, lessening down
> From infinite perfection to the brink
> Of dreary nothing?"

Until we have, let us be ever ready to grasp truth, wherever found, and lend idle hours to investigation.

REPORT OF THE STATE GEOLOGIST

AND

CURATOR STATE CABINET OF NATURAL HISTORY.

To his Excellency, HORACE FAIRBANKS,
Governor of Vermont:

SIR—I have the honor to submit the following report upon the condition of the collections in the several departments of the State Cabinet of Natural History for the years 1877, and 1878:

The collections constituting the "State Cabinet," with the exception of a portion of the Thompson collection, that have been ruined by the unavoidable dampness of the room, are in good condition, though the limited amount of space prevents their proper classification and arrangement. The older collection of minerals should be relabelled to correspond with the recent changes in nomenclature adopted by our best mineralogists, but the limited appropriation has thus far made such change impossible. We trust soon to be able to accomplish it. This change will make the geological collection much more valuable to the student, and at the same time more available to the people who visit the museum for comparisons, as well as to the casual observer.

The mineralogical collection consists of from eighteen to twenty thousand specimens, including additions, many of which possess rare value, as showing the geological structure of the State, and the forms under which its minerals are usually found.

Noticeable in the collection of fossils is the Fossil Whale, (*Beluga Vermontana*,) found in Charlotte, Vt., in August, 1849, during the excavation for the Rutland & Burlington Railroad. It was found in blue clay, lying from ten to fourteen feet below the surface, the head almost four feet higher than the tail. Its length is about fourteen feet, and what is very remarkable is that it is more nearly allied to the living than fossil species, thus presenting an almost insurmountable argument in support of the quite recent submergence of the valley of Lake Champlain beneath the ocean. (For full description, see Geology of Vt., page 162, or the Appendix of Thompson's Nat. Hist. of Vermont.)

Also fossil tusks, tooth and bones of an elephant found at Mt. Holly, (see page 933 of the Geology,) as well as fossil fruits and seeds found at Brandon, and the usual Champlain fossils found in the valley of that lake.

Nearly one hundred specimens of polished Vermont marble show the variety and excellence of the marbles of the State to be unsurpassed on the continent.

INDIAN RELICS.

Some twelve hundred Indian relics, all kinds included, belong to the collection, but only four or five hundred of the best are displayed in the case. Dr. J. M. Currier, of Castleton, presented a large collection of fragments of Indian work to the Cabinet last year, for want of room only a few are put on exhibition. Our collection consists of arrow points, pestles, boiling stones, knives, gouges, hoes, &c., as usually found; and quite a number of the peculiar tubes from the Indian burying ground in Swanton. They are of a drab color, doubtless made of clay and sand, and baked, some of them very hard, while others are baked harder on one side than the other, with now and then one quite soft. Perhaps forty in all have been found, one half of which are still in Vermont. Of the use the Indians put them to, we are in doubt. By one accustomed to blow the old fashioned stage horn they can be blown as a horn, and the noise they make is so similar to the call of a moose for its mate, that many suppose them intended for that purpose, as by their use the moose could doubtless be captured with ease.

Other articles from the graves mentioned are also on exhibition, and those who desire a full description will find the same in the "Proceedings of the American Association for the Advancement of Science," of 1873, in an exhaustive article written by Prof. Geo. H. Perkins, of Burlington.

FISH AND REPTILES.

This collection is the "Thompson" collection of Vermont fishes, described in his "Natural History of Vermont." The dampness of the State House is fast destroying them. This dampness originates during the period of nearly two years that intervenes without artificial heat of any kind being introduced into the house. The same injury is apparent in every room in the first story, and is injuring the house as well as the specimens in the Cabinet.

Our fish commissioners propose to furnish specimens of all the food fishes of Vermont, as soon as the State provides place for them, which, I trust, our next Legislature will do.

Additional room is also needed for arrangement and classification of the reptiles. Specimens, however, are thankfully received, as they can be preserved in alcohol until put on exhibition.

BOTANY.

The specimens of the grasses, sedges, &c., of Vermont, presented by Z. E. Jameson, are still in the Cabinet, and will be shown to those that wish to examine them, but as they are liable to damage are not on public exhibition.

INSECTS.

About one thousand specimens of Vermont insects are on exhibition. All new or peculiar insects are desired, and may be sent by mail as

heretofore. We would present thanks to those that have kindly contributed.

BIRDS.

About seventy-five specimens have been added since my last report. Our collection now contains most of our Vermont birds. Many belonging to the "Thompson Collection," not being properly prepared, have gone to decay, and have been replaced by new specimens as far as possible. Some three hundred species are represented by nearly four hundred specimens. It is still advisable that more should be added and that both male and female should be represented. To this end I shall collect as fast as possible.

ELGIN MARBLES.

In the drawers of the case, under the Indian relics, may be seen some casts of some of the celebrated Elgin marbles in the British Museum. This collection of ancient sculpture shows the highest development of Greek art in its maturity. As types of beauty they have never been surpassed, and they afford models of form, which have been used on vases and superb pottery to the present time, and these forms are so perfect that modern art has never even equalled them. The casts here seen are mostly from the frieze around the interior space in the Parthenon, and represent the combat of the Centaurs, the Panatheniac procession, the procession of cattle for sacrifice, and the various races and games of the times when they were made. They are in low relief, and represent some of the most perfect sculpture in the entire collection, which collection cost Lord Elgin fifty thousand pounds sterling, and was sold by him to the British government for thirty-five thousand pounds. and is now valued as the richest collection of sculpture in the world.

GEOLOGICAL WORK.

Having been called upon a number of times since my last report to make examinations of special localities, I would, for want of space, simply say that no great value of mineral worth has been found.

The Slate Quarry belonging to Charles T. Sabin of Montpelier, has also been surveyed, and finding it of a very superior quality, I thougt a few facts in relation to the same would be of interest. It is situated on the line of the Montpelier & Wells River, also Central Vermont railroad, the outcrops of slate forming the hill next beyond Seminary Hill, from the village. Tracing the probable extent of the slate by the outcrops, we have no doubt but that at least seventy-five acres can be easily available. The outcrops are about 136 feet above the valley below, thus easily supplying an inexhaustible amount of slate above the line of easy drainage, and the valley also furnishes ample room for the refuse material. Mr. Sabin has opened this quarry about half way up the hillside, and from the very first the slate has split with good rift, and perfectly flat. The slate taken from the quarry at this time is very tough, and can be split in tablets two feet square and one eighth of an inch in thickness. It is of a dark rich color that does not fade, is even in shade, very free from iron pyrites, and in every way a good slate for roofing purposes.

UNITED STATES COAST SURVEY.

I am happy to state that the "United States Coast Survey," through your application, is to allow a portion of the appropriation for the execution of the Geodetic triangulation of said survey to the State of Vermont.

I trust that by the aid of our State or her people, in erecting the proper signals in every town, that has a high hill, or mountain, that at least one point in each town may be fixed by the survey.

Agreeable to the law, I took pleasure in recommending the appointment of Prof. Volney G. Barber, of the University of Vermont, to take charge of, and execute the survey in this State. As the execution of the survey will be placed in able hands we expect the best results.

ACKNOWLEDGMENT.

Our special thanks are due to many that have aided us in saving various specimens of natural history, by sending them to us by express or mail, or writing us about them, so we could look after them. Our thanks in behalf of the State, and more especially of those interested in science, are due to the railroads, for their favors, in transportation, and otherwise.

From them we have received suitable accommodations for work in hand; and in behalf of those interested in science, we express to one and all, that have aided our work, appreciative thanks, for favors. It would only be just to the donors, and a pleasure to us, did we have space granted in our report, to mention the name at least, of every one aiding by donation or otherwise the increase of our collection: but such space not being allowable we can only express in a general way what we should be glad to make personal.

I am respectfully yours,

HIRAM A. CUTTING,

State Geologist and Curator State Cabinet.

Lunenburgh, Vt., Sept. 3, 1878.

NOTES

ON

BUILDING STONES,

ALSO ON

PLANT GROWTH,

BY

HIRAM A. CUTTING, A. M., PH. D.,

STATE GEOLOGIST, VERMONT.

MONTPELIER, VT.:
FREEMAN STEAM PRINTING HOUSE AND BINDERY.
1880.

BUILDING STONES.

WEIGHT, SPECIFIC GRAVITY, RATIO OF ABSORPTION, AND CAPABILITIES OF STANDING HEAT OF VARIOUS BUILDING STONES.

By HIRAM A. CUTTING, Ph. D., State Geologist, Vermont.

Having during the past pear instituted and carried out a series of experiments to ascertain as near as possible the capabilities of the various materials used in the construction of so-called fire-proof buildings to stand heat, I submit in tabulated form the result of such experiments, hoping they may be of use to the architects, quarrymen and insurance companies of our country, and also of some interest to others.

In connection with the capabilities of the various building stones to stand fire and water, I have taken their specific gravity and weight per cubic foot, so that the identity of the various stones could at any time be compared, and if in the working of a quarry there was a change in gravity, or weight, that it could be easily detected, and thus all who choose could know whether the tests given would apply or not.

I have procured sample specimens of the most important building stones in the United States and Canada, and after dressing them into as regular form as possible, three by four inches, and two inches in thickness, I have taken their ratio of absorption, which ratio I have expressed in units of weight, according to the amount of water taken up. If 450 units of stone absorbed one unit of water, I have expressed it thus: 1+450, meaning that the stone weighed 450 units when immersed, and 451 when taken from the water.

To accelerate the process of absorption, I have placed the specimens in water under the exhausted receiver of an air pump. I find that in this way as much water is absorbed in a few minutes as in

days of soaking. When specimens were removed from the water, I have before weighing, dried their outside with blotting paper.

In relation to the specific gravity, I have not followed Gilmore's rule in full. He weighed the specimens in air, immersed them in water, and allowed them to remain until bubbling had ceased and then weighed them in water, after which he took them from the water, dried them outside with bibulous paper, and weighed them again in air. From this last weight he subtracted the weight in water, dividing the dry weight by the difference.

This gave a specific gravity subject to two sources of error. I have followed the more frequent custom of weighing the dry stone, using pieces of two or three pounds in weight, and then immersing them in water. After the usual saturation I have taken their weight in water, subtracting it from the dry weight in air, and then dividing the dry weight by the difference. This gives the specific gravity of the rock itself, as usually found, which is what we desire, and I believe as it would usually be in buildings constructed of the given material. The specimens were previously dried by long exposure to a temperature not exceeding 200 degrees Fah. To verify this I have taken specimens from the quarries direct, and after weighing, have brushed them over with paraffine dissolved in naphtha, weighing them again so as to ascertain the exact amount of paraffine, which made no visible change in the stone, other than to keep out water. I have then weighed in the usual way, and thus obtained the exact specific gravity of the stone as in the quarry, and I find my method, used as stated, to give the best results, and so have adopted it.

After this I have placed them in a charcoal furnace, the heat of which was shown by a standard pyrometer. In many instances I have placed them side by side with dry specimens, but have been unable to note any marked difference in the action of heat, beyond this, that the dry specimens became sooner heated. I have, however, no doubt that the capacity of a stone to absorb water is against its durability, even in warm climates, and vastly more so in the changeable and wintry climate of New England. It is here often frozen before any considerable part of the moisture from autumn rains can be evaporated.

When the specimens were heated to 600 degrees Fah., I have immersed them in water, also immersing others, or the same, if uninjured, at varying temperatures up to 800 and 900 degrees, that is, if they are not spoiled at less temperatures. I find that all these samples of building stones have stood heat without damage up to

500 degrees. At 600 degrees, a few are injured; but the injury in many cases commences at or near that point. When cooled without immersion, they appear to the eye to be injured less, but are ready to crumble, and I think they are many times nearly as much impaired, and always somewhat injured, where water produces any injury.

I give you results in tabulated form:

GRANITES.

NO	KIND.	LOCALITY.	Specific Gravity	Weight per cubic ft. in lbs.	Ratio of Absorption.	Degree of heat causing first appearance of injury.	Degree of heat causing first appearance or cracking or crumbling.	Degree of heat which causes general cracking and friability.	Degree of heat necessary to render it worthless.	Degree of heat necessary to melt or destroy.
1	Light Colored.....	Hallowell, Maine.....	2,638	164.8	1+790	800 Fah.	900 Fah.	950 Fah.	1,000 Fah.	1,100 Fah.
2	" "	Fox Island, Maine.....	2,642	165.1	1+680	700 "	800 "	850 "	900 "	1,000 "
3	Denning's Quarry.....	Mount Desert, Maine....	2,631	164.1	1+716	800 "	850 "	950 "	1,000 "	1,100 "
4	Light Colored.....	Rockford, Maine.....	2,600	162.5	1+482	600 "	800 "	850 "	900 "	950 "
5	Red	Red Beach, Calais, Maine	2,636	164.7	1+560	800 "	850 "	900 "	950 "	1,000 "
6	Light Colored.....	Oak Hill, Maine.... ...	2,526	157.8	1+310	800 "	850 "	900 "	950 "	1,000 "
7	Red	Stark, New Hampshire..	2,631	164.1	1+534	600 "	700 "	800 "	850 "	950 "
8	Color Medium.	Concord, New Hampshire	2,636	164.7	1+778	800 "	900 "	950 "	1,000 "	1,200 "
9	Sanborn's Quarry.....	Plymouth, NewHampshire	2,649	165.5	1+685	800 "	900 "	950 "	1,000 "	1,200 "
10	Carter's Quarry.....	Ryegate, Vermont.....	2,647	165.4	1+790	800 "	900 "	950 "	1,000 "	1,200 "
11	" "	Woodbury, Vermont....	2,654	165.8	1+784	800 "	900 "	950 "	1,000 "	1,200 "
12	Wetmore & Morse's Quarry.	Barre, Vermont.....	2,651	165.6	1+720	800 "	900 "	950 "	1,000 "	1,200 "
13	Syenite	Quincy, Massachusetts...	2,660	166.2	1+650	750 "	800 "	850 "	900 "	1,000 "
14	Gray	Groton, Connecticut.....	2,800	175.	1+818	700 "	750 "	800 "	900 "	900 "
15	Common.	Woodstock, Maryland...	2,648	165.5	1+394	700 "	750 "	800 "	900 "	900 "
16	"	Port Deposit, Maryland..	2,700	168.7	1+816	800 "	900 "	950 "	1,000 "	1,100 "
17	Scranton County Quarry..	Richmond, Virginia.....	2,727	170.5	1+398	750 "	800 "	850 "	900 "	1,000 "
18	Old Dominion Quarry.....	Richmond, Virginia.....	2,674	167.7	1+402	750 "	800 "	850 "	900 "	1,000 "
19	Light Color.....	St. Cloud, Minnesota....	2,690	168.2	1+280	700 "	700 "	800 "	850 "	900 "
20	" "	Stanstead, P. Q.....	2,833	177.	1+420	800 "	900 "	1,000 "	1,000 "	1,200 "
21	Coarse.....	North Halifax, N. S.....	2,698	168.6	1+584	700 "	800 "	800 "	900 "	900 "
22	"	Gananogue, P. O., Canada	2,687	167.9	1+736	800 "	850 "	900 "	950 "	1,000 "

Sandstones.

23	Freestone	Portland, Conn	2,380	148.7	1+27	850 Fah.	900 Fah.	950 Fah.	1,000 Fah.	1,100 Fah.
24	"	North of England	2,168	135.5	1+27	850 "	900 "	950 "	950 "	1,000 "
25	Seneca Stone	Montgomery County, Md.	2,500	156.2	1+26	850 "	900 "	900 "	950 "	950 "
26	Sandstone	Salem, Md	2,452	153.2	1+24	850 "	900 "	950 "	1,000 "	1,100 "
27	"	Seneca, Md	2,410	150.6	1+40	900 "	1,000 "	1,100 "	1,200 "	1,200* "
28	Montrose Stone	Ulster County, N. Y	2,661	166.3	1+314	900 "	1,000 "	1,100 "	1,200 "	1,200 "
29	Freestone	Bellville, N. J	2,350	146.8	1+27	900 "	950 "	1,000 "	1,000 "	1,100 "
30	"	Nova Scotia	2,424	151.5	1+240	900 "	950 "	1,000 "	1,000 "	1,100 "
31	S. Carboniferous	Br. Phillips, N. S	2,353	147.0	1+19	900 "	950 "	950 "	1,000 "	1,000 "
32	Freestone	Dorchester, N. B	2,363	147.7	1+26	800 "	850 "	900 "	1,000 "	1,000 "
33	Cincinnati Stone	Cincinnati, Ohio	2,188	136.1	1+23	900 "	950 "	1,000 "	1,100 "	1,100 "
34	Potsdam Sandstone,	McBride's Corners, Ohio.	2,333	145.8	1+28	800 "	850 "	900 "	1,000 "	1,100 "
35	Berlin Stone	Cleveland, Ohio	2,210	138.1	1+22	850 "	900 "	1,000 "	1,100 "	1,100 "
36	Potsdam	McBride's Corners, Ohio.	2,500	156.2	1+22	850 "	900 "	950 "	1,000 "	1,000 "
37	Euclid Stone	Near Cleveland, Ohio	2,290	143.1	1+35	850 "	900 "	950 "	1,000 "	1,000 "
38	Berea Stone	Berea, Ohio	2,254	140.8	1+20	850 "	900 "	950 "	1,000 "	1,000 "
39	Amherst Stone	Amherst, Ohio	2,200	137.5	1+18	850 "	900 "	†	†	1,000 "
40	Brown Stone	Humbletown, Penn	2,346	146.6	1+28	850 "	900 "	950 Fah.	1,000 Fah.	1,000 "
41	Potsdam Sandstone	Beauharnois, P. Q	2,512	157.0	1+38	850 "	900 "	950 "	1,000 "	1,000 "
42	Sandstone	Murray Boy, P. Q	2,577	161.0	1+36	900 "	950 "	1,000 "	1,100 "	1,100 "
43	"	Cheat River, W. Va	2,632	164.5	1+80	800 "	850 "	900 "	1,000 "	1,100 "
44	Freestone	Acquia Creek. Va	2,183	136.4	1+16	900 "	950 "	1,000 "	1,100 "	1,200 "
45	Brown Stone	Manasses, Va	2,348	146.7	1+17	850 "	900 "	1,000 "	1,100 "	1,200 "

*Will stand greater heat.
†Changes color.

Limestones.

46	Limestone	Baltimore, Md	2,917	181.8	1+340	900 Fah.	1,000 Fah.	1,100 Fah.	1,200 Fah.	1,200 Fah.
47	"	Bedford, Ind	2,478	154.8	1+280	850 "	900 "	1,000 "	1,200 "	1,200 "
48	Cincinnati Limestone	Hamilton County, Ohio	2,204	137.7	1+28	850 "	900 "	950 "	1,200 "	1,200 "

LIMESTONES.—*Continued.*

NO	KIND.	LOCALITY.	Specific Gravity	Welght per cubic ft. in lbs.	Ratio of Absorption.	Degree of heat causing first appearance of injury.	Degree of heat causing first appearance of cracking or crumbling	Degree of heat which causes general cracking and friability.	Degree of heat necessary to render it worthless.	Degree of heat necessary to melt or destroy.
49	Potts Blue	Springfield, Penn	2,666	166.6	1+280	850 "	850 "	900 "	1,000 "	1,200 "
50	Dolimite Limestone	Owen Sound, P. O	2,571	160.6	1+480	850 "	900 "	1,100 "	1,200 "	1,200 "
51	Trenton Limestone	Montreal, P. Q..	2,706	169.1	1+316	900 "	950 "	1,000 "	1,200 "	1,200 "
52	Limestone	Isle La Motte, Vt	2,696	168.5	1+320	950 "	1,000 "	1,100 "	1,200 "	1,200 "

MARBLES.

53	Tuckahoe	Westchester County, N.Y.	2,794	174.6	1+298	900 Fah.	1,000 Fah.	1,200 Fah.	1,200 Fah.	1,200 Fah.
54	Ashley Falls	Ashley Falls, N. Y	2,742	171.3	1+280	900 "	1,000 "	1,100 "	1,200 "	1,200 "
55	Snow Flake	Westchester County, N.Y.	2,848	178.0	1+380	950 "	950 "	1,000 "	1,200 "	1,200 "
56	Tennessee	Do'gherty's Qu'ry, E. Tenn	2,711	169.4	1+320	950 "	950 "	1,000 "	1,200 "	1,200 "
57	Duke Marble	Near Harper's Ferry, Va.	2,812	175.7	1+340	1,000 "	1,000 "	1,100 "	1,200 "	1,200 "
58	Black Marble	Isle La Motte, Vt	2,682	176.6	1+320	1,000 "	1,000 "	1,100 "	1,200 "	1,200 "
59	Sutherland Falls	Rutland, Vt	2,666	166.6	1+342	1,000 "	1,000 "	1,100 "	1,200 "	1,200 "

CONGLOMERATES.

60	Conglomerate	Roxbury, Mass	2,708	169.2	1+49	700 Fah.	800 Fah.	900 Fah.	1,000 Fah.	1,000 Fah.
61	Potomac Stone	Point of Rocks, Md	2,724	170.2	1+60	600 "	700 "	800 "	900 "	900 "
62	Conglomerate	Caps a La Aisle, P. Q	2,645	165.3	1+80	600 "	700 "	800 "	900 "	900 "

Clay Slate.

63	Sabin's Quarry.....	Montpelier, Vt.....	2,869	179.3	1+110	800 Fah.	850 Fah.	900 Fah.	1,000 Fah.	1,209 Fah.

Soapstone.

64	Soapstone.....	Weathersfield, Vt.....	2,668	166.7	1+318	1,200 Fah.	.....	.....	.....	.....

Artificial Stone.

65	Artificial Stone.....	McMurtire & Chamberlain patent.....	2,235	139.7	1+280	750 Fah.	800 Fah.	1,100 Fah.	1,200 Fah.	.....

I would remark that my experiments with granite show that there is quite a range in their capability of standing heat—a range, in fact, much greater than I anticipated. With the sandstones the difference is also marked as is their power of absorption. When exposed to heat wet, they show a marked difference in the time required to heat them, the saturated ones seeming to resist the heat for a time; but when equally hot they crumble the same as those not previously saturated. Their relative worth can be seen by the tables. The conglomerates stand heat badly while the limestones and marbles stand best of all (up to the point where they by continued heat are changed to quicklime), except soapstone, and a species of artificial stone made under the McMurtire & Chamberlain patent.

The indications are from this and other samples that it may be possible to make an artificial stone cheaper and better for fire-proof buildings than our native quarries furnish, and we hope this possibility may receive attention. But comments are useless, as the facts set forth in the tables speak for themselves.

CURIOSITIES OF PLANT GROWTH

AND THE WORTH OF SUCH OBSERVATIONS TO THE FARMER.

By Dr. HIRAM A. CUTTING, State Geologist.

It has been ascertained by a multitude of observations, that the plants which we meet in every section and which become so familiar to every person, while they are in most instances rooted in the soil, derive 95 per cent, or more, of their actual weight from the atmosphere. While the food derived by the plant from this atmosphere is beyond our control, the small portion of its food derived from the soil is of very great importance, as a proper condition of the soil is always necessary to enable the plants which are of the greatest value to man to take such an amount of food from the atmosphere as to bring them to a perfect maturity. To thus adapt the soil, so as to enable the plant to perfect itself and thus give a more vigorous offspring, is the science of agriculture. To perfect ourselves in that science we must be observers of nature, and then turn our own observations, or the observations made by others to account. We all know that plants grow, and that vegetable growth is the development of the several parts of a plant, according to a definite, pre-determined plan, as regards general form, size and other characteristics of the species under consideration. We further know, that that condition is the result of an active, inherent force called life. When we by aid of high magnifying power seek that force, or that principle of life, to our view it is presented to us as a cell, and when we magnify further we find that cell of growth contains a substance which is called protoplasm, of which I shall speak by-and-by.

Thus we find that whether animal or vegetable, the first origin of life is a simple cell. This is in fact fully shown by the microscope, yet when Dr. Wm. Harvey of England first announced this fact in 1650, and also that blood circulated in the arterial system of all the animal creation, instead of air, which was previously supposed to permeate our system as it does the bodies of birds, it was viewed with astonishment by all, and doubted by many. From this beginning the true principles of circulation have been shown to originate

in the germ, or cell, whether animal or vegetable, and on that circulation the growth depends. Harvey commenced his observations on embryology by observing the development of the embryo in eggs, which he kept for the purpose under a setting hen in the chamber of a friend. For more than 200 years this study has received the attention of scientific men, some devotees observing embryol development in many thousand cases, yet all have failed in the main points, though much has been learned. If the inquiry into the origin of life is so baffled concerning the changes which occur in the almost transparent material of an egg, out of which the varying organs and fluids of the complete animal are developed, can we expect success when we attempt the study of the reproduction, and growth of plants? The hardness and opacity of the seeds, the complex chemical constitution, and exceeding simplicity of its cellular tissue, within whose secret chambers the processes of vegetation are carried on, all conspire to discourage and bewilder the investigator.

Some seeds retain their vital energies but a few hours, as the seeds of the willow, while others retain that vitality for centuries, like the wild cherry, or even our cultivated wheat. If two ripe seeds from the catkin of a willow are taken, and one placed in suitable earth, and the other in a dry room, both change rapidly. In 12 hours the one in earth is ready to burst its integuments, and in 18 it is sending its roots downward according to the law of gravitation, but its plumule, or stalk, upwards, towards light and air, in opposition to the same law. Yet the difference is so slight in the willow, that after the stem of the tree is formed, it may be inverted, and its limbs nourish the roots, which send forth leaves. Then re-inverted with the same result, not only once each year, but once in from 4 to 6 weeks, the entire growing season. Of our other seed, in a few hours it has lost its vitality without much apparent change. If now placed in the earth it absorbs moisture as before, but only to hasten its decay, as from some unknown cause that germ known as life has departed.

Our growing willow increases in size until autumn. Its leaves then fall, but not from cold, but because a period of rest is needed, similar in some respects to the hibernation of animals. This annual cessation of growth is essential to the health of most species, yet in some, like the orange or lemon, it is not so apparent. From this requirement, more than any other, the failure to blossom arises in our hot-house plants, because that period of rest, either from cold in northern sections, or from drouth in tropical countries, is not given them. During that period of rest most trees contain less

water, or sap, and seem to harden in all their tissues. But what is this growth of which we have spoken, and as we shall show in our most fragile plants, so considered, is capable of raising tons? Of course it is from the nourishment received in some way by the plant, and it requires only limited observation to decide that it must in the main be through the rootlets and annual leaves; as the animal takes food through its mouth, so does the plant through its little rootlets, some too small even to be seen by the naked eye. As the animal breathes so does the plant, in a manner peculiar to itself through its leaves, which have large numbers of stomata, or breathing pores, usually most numerous on the under side. The leaf of the lilac has none on the upper surface, but as many as one hundred and fifty thousand to every square inch of its under surface. These breathing pores are so constructed that when the atmosphere is dry they nearly close, and open wide when it is damp, but always remain shut except under the stimulus of light. Thus a tree in dry weather, by keeping these pores shut, retains the water otherwise evaporated from the sap through the leaf, and thus prevents dryiug up and cracking; but its growth is also checked, as it is through the leaf that the excess of water is disposed of, and the valuable plant food taken up as dissolved by the water, retained, and appropriated to cellular growth.

In regard to the size of these vegetable cells, it is difficult to obtain a correct conception, unless the reader is conversant with the use of the microscope. In every cubic inch of maple wood, for example, there are doubtless no less than one hundred millions of cells of the various tissues. The average diameter of plant cells is usually less than one four-hundredth of an inch, and even the ducts or continuous tubes are not usually much larger, and are often much smaller than this. Prof. Gray says, "that in these tubes, in basswood, which is one of our less compact woods, that sap must pass through 2,000 partitions in every inch of its ascent." In this way it must in an ordinary tree pass millions of such membranous walls in passing from the rootlet that takes it in to the topmost leaf by which the moisture may be exhaled. The vegetable kingdom was created for evident purpose, as on that depends not only all the food, but all the vital air, which is indispensable to animal life. Every growing plant is a machine, converting mineral matter into digestive substances, which may be eaten, and nourish various animals, and at the same time exhaling continually under the stimulus of sunlight, from its myriads of stomata, pure vapor of water and oxygen gas, indispensable to the life of all animals. Why do not ungrateful persons con-

sider this wonderful work of the Creator? But this is not all, as the plant gives food to man, and an atmosphere on which his life depends, it takes substances deleterious to the animal from the atmosphere, appropriating them to its own use. The substance taken chiefly is carbonic acid gas; this is absorbed by the green parts of the plant through pores for the purpose, and nearly one-half of the weight of dry vegetable matter is thus obtained.

Vegetable growth, as derived from the two sources named, is an increase in size and weight, in consequence of the multiplication and enlargement of cells, and occurs chiefly in the vicinity of the cambium layer, so called, which in the growing season envelops every root, stem and branch between the wood and bark, and permeates between the two outside layers of every leaf. The mode of this cell development has been carefully studied by the aid of the microscope, and may best be observed in aquatic plants.

The vital fluid, corresponding somewhat to the blood of animals, and existing in every growing vegetable cell, is called protoplasm. This is usually thin, and sometimes nearly colorless, and encloses a minute globule, called a nucleus, which often contains other nuclei more minute. The contents of each cell show motion, usually circular, within its walls. The contents of adjoining cells frequently having motion in opposite direction. There are two general modes of growth. In simple plants, it is common for the protoplasm to gather itself in two portions within the parent cell, and develop a nucleus membrane for each. These young cells then grow, burst or absorb the membrane of the original cell, thus becoming independent. In all our higher plants a different process is observed. The protoplasm first begins to contract in the central portion, and thus divides or develops a new protoplasm, for the cell about to be formed. Each portion then grows, the new cell repeating the process. Thus the plant goes on increasing both above and below the ground.

In a growing plant the cells are first formed at the tip of the stem and subdivision there goes on during the period of growth; but it is believed that all vegetable material is primarily formed in the leaves, or green parts, of ordinary plants, and then passes, by circulation, to the point of growth. If so, it is of course transferred in liquid form, but just the process is as yet hidden from human eye. We, however, are led by reason, to admit that life as developed in the plant is a molecular force, capable of exerting great power. Increase of wood cells may sometimes take place under great pressure, as in my native town I have visited, frequently, a large yellow birch that rests upon a big rock, sending its roots down to the soil for

nourishment, and annually producing its regular growth; yet the whole tree, which must weigh at least four tons, is raised as regularly the thickness of the grain of new growth formed upon those roots, each year, which is about a quarter of an inch. Since my observations commenced upon it, the entire tree has thus been raised four inches. This in no way interferes with the statement of facts made by Prof. Asa Gray, and other eminent botanists, that two points in a vertical line on the trunk of a tree will not separate as the trunk enlarges, as no tree is raised by its growth more than half the diameter of the roots, and only thus, when a tree stands upon a solid foundation. When therefore, any writer asserts, as has often been, that carving or letters made by him years before, are high above his reach, it has no foundation in fact.

The following illustrations show this point more fully: At Walton Hall, in England, in 1853, was to be seen a filbert tree, the seed of which was planted in the central hole of a millstone in 1812. This tree had grown until it had completely filled the hole in the stone, and standing upon a rock beneath, its growth then raised the millstone full 2 inches from the ground. In Middlesex, Vt., there now stands an elm beside the highway, with a large rock beneath it, and a rock weighing some 30 pounds, (which was doubtless rolled against the tree when young) imbedded in the tree, and raised nearly four inches from the ground. Thus the growth of a tree raised not only ts own weight but that of a foreign body by its annual growth. In Concord, Vt., a spruce tree growing near a large granite boulder, sent a root under it, and thus raised this boulder on the side next the tree, 4 inches, though it had no other rest upon that side than the root which grew between that and the rock beneath. The amount of stone raised by this root is not less than 5 tons. From the above examples it is clearly demonstrated that the power of vegetable growth can lift not only trees but the additional weight of large stones, whenever the roots cannot be depressed in the soil by reason of having a solid substance beneath them.

But we will now consider this power in smaller plants. It is a well known fact that beans, corn and other vegetables, will lift a considerable weight in coming up through the ground, providing they meet with such obstruction as a stone or lump of dried dirt. Mushrooms have great lifting power, and sometimes raise door steps and large flagging stones. Recently in Worcester, England, a gentleman noticing a large stone in his walk raised somewhat, sent for the police, thinking burglars had been at work. The stone was taken up

and the rogues were discovered in the shape of three giant mushrooms, which had raised at least about 80 pounds.

But the expansive power of vegetable growth has been more fully illustrated by Prof. W. S. Clark of Amherst, Mass., who has grown a squash in harness, or in other words, when subjected to a pressure of over 4,000 pounds. This squash after obtaining its growth under immense pressure, (commencing its life under a pressure of 60 pounds, which was gradually increased to upwards of 4,000) weighed 47 pounds. This is not only proof positive of the great power of vegetable growth, but certainly shows a great capability of exertion under difficulties, which might be a comparative lesson even for man.

Another capability of vegetation, often overlooked, is the immense expansion of root.

With a few exceptions from the first development of the plant the roots tend downwards, seemingly in accordance with the laws of gravitation, until from their need of food, or otherwise from the compact nature of the soil, or from rocks, they expand in all directions. Their growth is in great part by lengthening, and very slowly in size. The point of growth in a root is not, as in a twig, at the very end, but a short distance from it, perhaps in our common cultivated plants about one-sixth of an inch. In transplanting trees this end is quite likely to be broken off, and if so the root broken never extends itself; hence may be seen the absolute necessity, (if you would have your trees thrive well), of transplanting with care, and as such growth continues in a direct line, unless some obstruction turns it one side, you can see the necessity of straightening out and thus directing the rootlets of the tree you transplant, as by so doing you will forward its growth, by one-half, for the first five years, at least.

In a large tree and, in fact, with most plants, not all that branching portion beneath the ground are true roots; they are subdivisions of the stem to hold it erect, or in a solid position. The nourishment is in the main received from the rootlets that are no larger than knitting needles, and smaller.

It is an erroneous opinion with those who think that nourishment is only taken in at the end of the rootlet, for none is there taken, but it is taken all the way its entire length, unless it is old and covered with a bark quite like the part above grownd. The rootlets that assimilate food when examined by a microscope are seen covered with minute hairs, which are tubular elongations of the external root cells, and are all so many mouths to supply the plant with

proper nourishment. They are in reality innumerable, or, in other words, beyond the power of the human mind to comprehend their number. Their length is also simply beyond computation.

The root of the elm has been dug out of the soil in its healthy state 40 feet below the surface. I have seen the roots of a maple tree which stood 65 feet from a grave, which was 5 1-2 feet deep, and where the burial had taken place 15 years before, not only enclose the coffin with hundreds of rootlets, but to completely fill it with a network of the fibrous rootlets no larger than ordinary threads. Of course all the remains the coffin formerly contained had been stolen away to make up the tree growth. Clover roots have frequently been washed out of a sandy soil on the banks of streams in New England from 4 to 9 feet in length. Parsnips have been dug out of alluvial soil in California, 14 feet long, and by Mr. Dixon of Riven Hall, England, 13 1-2 feet long. Of the two last named plants, the roots run perpendicular into the soil.

Many supposed cases of fossil wood, found 40 or 50 feet below the surface, are shown by the microscope to be roots of trees vegetating on the surface. Such supposed fossils were a few years ago found 35 feet beneath the surface at Burlington, Vt., but by recent examination I find these fossils, so called, to be elm roots. But this seemingly incredible length of root in this section is not only doubled, but even twice as long in warmer countries. In India, roots of plants and trees are frequently dug up for economical purposes, to the depth of 60 or 70 feet, and in South America, even deeper, without in either case reaching the end of the roots. Elm roots have been known in Randolph, Vt., to obstruct an aqueduct for conveying water, 370 feet from the tree, and it has recently been stated in an English agricultural paper, that a tile drain was obstructed by the roots of an elm 450 feet from the trunk of the tree.

The rootlets of Indian corn may be found any season on good soil from 4 to 10 feet from the plant, and in my cornfield this year, with hills 4 feet apart each way, when you look 1 inch below the surface you cannot find a cubic inch in the field which is not permeated with the rootlets for at least 10 inches in depth. This demonstrates fully the folly of using phosphate or any other fertilizer in the hill, for you cannot hide it in your field where the rootlets will not find it; and how much better to have your plants find a regular supply for the season, and consequently mature the fruit, than to be stimulated into a rapid growth the first part of the season to be blighted for want of nourishment when maturing fruit. If I put but 100 pounds of phosphate or other concentrated manure upon an

acre, I should sow it broadcast, as by so doing your plants find a regular supply for the season, and not an excessive one for a short time, which, when exhausted, leaves the plant in a worse condition than it would have been if it had never had it. I have spoken of corn, but other plants have similar rootlets and are subject to the same laws; as shown by Prof. Clark of Amherst, the roots of the squash have a length almost incredible, as one grown in a hot house box by him had an aggregate length of over 2,000 feet.

It is well understood by all that the water and plant food taken up by the rootlets circulates as sap through the tree and as in the animal a life principle is necessary for that circulation, yet just how it is accomplished is a mystery. I shall lay down no regular rule for nature to work by; as I believe that the circulation of sap in all plants may not be produced in the same manner; I shall speak of observations made by myself, and others, illustrative of facts in such circulation in plants and trees most familiar to all. In 1720 Rev. Stephen Hales, of England, observing a grape vine bleeding abundantly, and fearing injury endeavored to stop the flow by tying a piece of bladder over it. This was forcibly distended, and he attached a gauge and by a series of experiments determined that the pressure from the end of a grape vine would equal the pressure of a column of water 43 feet high. Almost all writers on plant growth since that time have said something about this experiment, but a large majority have spoken of this vine as an exception to the pressure exerted generally in sap circulation in different plants.

Led by the great flow of maple sap in 1853 to investigate specially the sugar maple, I found that by screwing a stop cock, with a pipe attached, into a tree that the sap would rise in the tube to the top of the highest branch on the tree subjected to the experiment, and sometimes a few inches higher. Finding also that the proportionate amount of sap discharged was according to the height above the tapping, as though the sap stood on pressure in the tree, I was led to examine farther into the circulation and found, after freezing, a microscopic change in the sap wood, showing rupture of the membranous partitions and enlargement of the ducts themselves. This is doubtless the result of freezing and as the outside of the tree freezes first there is a pressure also exerted by the expansion of the sap tending to force it in towards the centre of the tree, and a greater amount of sap is found after a severe freeze in the heart wood than at any other time. In this way it will be seen that the sap may in reality be held in large part on pressure and leak as it appears to, in the maple, from the ducts cut off in tapping, as fast

as their capacity will admit of. The variation is however very great. Dr. Williams, in his history of Vermont, says: "A man much employed in making maple sugar, found that for 21 days together a maple tree discharged 7 1-2 gallons per day." This would make a total of 157 gallons from a single tree. An American agricultural journal in 1842 stated that 20 gallons of sap was drawn in 18 hours from a siugle maple tree, 2 1-2 feet in diameter, in Warner, New Hampshire; Emerson in his "Trees of Massachusetts" mentions a maple 6 feet in diameter which yielded a barrel of sap in 24 hours, and of another tree that yielded 175 gallons in course of the season. A maple tree in this town for several years yielded on the average 30 pounds of sugar, which would necessitate about 600 pounds of sap per annum. In 1860 the owner of the sugar place in which this tree was situated made 2,160 pounds from 200 trees and the tree before mentioned produced 42 pounds. Last spring, Mr. Reed, who carries on this sugar place, though the number of trees has increased by the addition of second growth trees, averaged 6 pounds to a tree, and a large second growth tree in an open field, owned by a Mr. Lamson, was tapped and the sap boiled at the house, and run in small cakes for sale; their weight was 21 pounds. The sugar made in that locality is very free from the malleate of lime, or sugar sand, so called, that is so common in many sections. I have consequently examined the sugar place and section round about and found no visible cause why maple trees should run so much more sap in this special location; yet such is a fact. I have carried on some experiments elsewhere to see what fertilizing substance, if any, would increase the flow and sweetness of sap. I have met with signal success, and find that wood ashes will not only double the usual amount of sap, but will make it much sweeter. To have a marked effect a dozen bushels should be strewn about the tree extending some 5 rods from it in every direction. There need be none put within 8 or 10 feet of the tree. They should be put on in the summer previous, but the effect is for years. Plaster of Paris also will increase the flow. So will stable manure, or any other fertilizer, but not as much as ashes alone. The malleate of lime, which is such a bane to sugar makers, does not seem to be increased in amount by fertilizing.

I have found maple sap to flow at all seasons after sufficient cold to freeze the outside grains of wood, followed by a day in which the warmth would thaw the tree. During the past 25 years this has taken place here as early as September 20th, and as late in the spring as June 14, in which freeze the entire foliage of the maples were

killed. The second crop of leaves came rapidly forward but were about one-half the usual size. Many plants and trees when they awake from their winter repose shed sap freely when punctured, and by experiments carried out by Prof. Clark, president of the Massachusetts agricultural college, it seems they show variety of pressure, and after a time the maple and some other trees will take in by suction large amounts of water which go into the circulation. In my own experiment I have endeavored to have coloring material absorbed in this way, but with slight exceptions have failed in the attempt, yet alkaline and brackish waters will be absorbed, resulting in all my experiments in the death of the tree. In relation to this subject thousands of queries naturally arise which are in the greater part, as I have before said, unanswered.

The reason why the maple secretes cane sugar, and birch grape sugar, or how any sugar at all is secreted, are some of the questions easily asked but not so easily answered. There is but a step in chemistry from starch to sugar, and that the elaborated sap of autumn would contain starch, and the fact that sulphate of lime in the soil will increase the sweetness of the sap, leaves us a chance for conjecture, that the change may be in accordance with well known chemical laws; yet just how it is accomplished may ever remain a mystery. How the sap is taken up and such a pressure maintained by the rootlets, which at the same time have the capability of inverting their power of work, is unknown. If a sprout from a root have the root extending from it cut close to the sprout, and then brought above the surface, the end cut at the sprout will not only discharge sap, but convey nourishment taken from the tree through other rootlets, thus showing its double action. Trees that do not shed much sap, may even be inverted when of considerable size, and the limbs answer as roots, and *vice versa*, showing double action. Some have accounted for the circulation of sap by capillary attraction and osmose action, as well as by various theories; but might it not be as well to allow something for the life action of the plant, as to try and account for it by theories that are not only unreasonable, but inefficient?

There must be a vital action of the life principle of the plant in some direction, or else we could not distinguish the dead from the living. May it not be as with the animal to secure its food; and may not different plants, as well as different animals, feed not only on different substances, but in various manners?

The immense amount of water taken up by the rootlets, and containing but little plant food, must be in some way expelled so the

proper material may be used to increase the tree. This is evaporated through the leaves, and it will be seen that a large tree must evaporate hundreds of gallons every day when growing with rapidity. This then affects the atmosphere, giving an excess of moisture to the atmosphere in wooded countries.

There is much to study in reference not only to the flow of sap, or the manner of growth of the plants we raise for the use of man, but for our advantage it should be directed to the best and most economical manner of giving to each plant its proper food. I am now carrying on various experiments in that direction, and shall be glad to correspond with any persons interested in the same subject.

[From the Proceedings of the American Association for the Advancement of Science. Portland Meeting, August, 1873.]

Direction of Wind in Local Thunder Storms.

By Hiram A. Cutting, of Lunenburgh, Vermont.

In July, 1850, at Franconia, N. H., I was exposed in a buggy to the fury of one of those local showers that pour rain in torrents, accompanied by some hail and much thunder and lightning.

As I was riding leisurely along I observed a small black cloud almost directly overhead. It increased with great rapidity, and in ten minutes the torrent came down. The wind was in gusts from all points of the compass, demolishing my umbrella in a twinkling, leaving me to the mercy of the elements. I was drenched in a moment and in an incredibly short space of time the body of the buggy was full and overflowing, though nearly four inches in height.

The roads were like rivers and everything was flooded. In driving north three and one-half miles I passed entirely out of the limit of the storm of hail and rain, but the wind for two miles further had been violent from the south, prostrating corn and some trees and blowing down one barn. The next morning I repassed the ground and found that the southern limit of the storm was about six miles from its northern limit, and that at that part the wind was strong from the north, doing some damage.

In the afternoon, I visited the iron ore hill in Lisbon, which lies west of the centre of the shower, and found the wind there had been strong from the east. Upon my return I examined carefully by the plants and trees, and by inquiry, into the direction of the wind and found it upon the westerly side, in every instance direct from the storm and all described it as cool, though the forenoon of the day of the shower was very hot and sultry with so little wind, that I was unable to learn its direction.

As the eastern limit of the storm was towards the White Mountain range and a wilderness, I could get no information of its extent or severity, only by the rise of the streams fed by it, which was very great on all little streams, within or running through the limit of a circle six miles in diameter.

Upon my return home to Concord, Vt., I resolved to investigate fully the next storm of similar import. I soon removed to Lunenburgh, where I now reside, but saw nothing of similar storms until June 30, 1856. The morning was sultry, the forenoon hot, with thermometer at 98°. The wind was unsteady, but from southerly points. At about noon a dark low cumulus cloud appeared in the west, which rapidly increased in size, until it hung with inky blackness over the east part of Concord about five miles away. At noon, there was a strong breeze from the east, setting directly towards this cloud and quite steady. At one o'clock P. M., there was a hard gusty wind blowing directly from the shower, feeling quite chilly after the forenoon heat and causing the thermometer to fall in a few minutes to seventy degrees.

The cloud hung over the same place for half an hour longer, when it became lighter and was soon broken up in fragments and dissipated. During the afternoon, small showers came up round about and at three it rained slightly at Lunenburgh.

The next morning, hearing reports from the hail storm, I went to the field of disaster. I found the storm of great severity but of limited extent, being all within the radius of one-half mile. When within a mile of the storm there were indications of a strong wind from the west (I was approaching from the east) sufficiently so to blow down many trees beyond the limit of the hail and rain. I found, upon examination, some trees blown down upon every side of the storm, yet the wind invariably from the storm cloud. Upon inquiry, I found the wind, as far as noticed before its commencement, blew directly towards it from all quarters. The storm, though so limited, was of unusual violence, in fact almost without precedent in this section. The lightning was terrific, striking trees, etc. The testimony showed the thunder the heaviest ever known and almost incessant.

The cloud, to the parties living there, seemed, as it appeared to me five miles distant, to form directly overhead, the atmosphere seemed very sultry while it was forming, with hardly a breath of air. I could not learn that there was any special direction of the

wind and think there was not enough to note. The cloud formed so rapidly, that the farmers in their fields did not leave their work until an almost total darkness settled down upon them, yet with the opportunity of seeing a band of clear sky in all directions, at the horizon. There was a strange feeling of oppressiveness in the atmosphere. When the storm commenced at one o'clock P. M., a complete deluge of water first came down, followed almost immediately by hail stones and chunks of ice several inches in diameter which seemed pressed to earth with a violent wind crushing branches down from the trees with fearful violence. The duration of the storm was no more than thirty minutes, yet in a circle one mile in diameter no green thing was left. The leaves, branches and even the bark, were stripped from the orchards and shade trees. A sugar orchard standing in the storm was destroyed in the same manner. The shingles from the roofs and some boards were battered from the buildings and broken in pieces by the ice. The glass and sashes were all broken. The grass crop was entirely destroyed so that the grass fields looked like ploughed ground and it was next to impossible to find straws more than two inches long. What became of the heavy crop of grass, ready for the harvest, I cannot say.

Potatoes well hilled up by twice hoeing were destroyed and the ground levelled as though it had been done with a roller, and no stalks of potatoes or corn could be found upon all the ground. The hail stones and masses of ice were piled up like snow drifts in winter; and twenty-four hours after the storm, in one drift by actual measurement there were over twenty-five cords. Upon the outer edge of the storm where the outward wind was strong there was only rain, and a mile from the centre there was only wind, which extended at least from five to eight miles away; how much farther I cannot say. The section, over which the hail fell, was left without a particle of verdure. No green leaves could be found. It presented a state of devastation, as though the trees had all been stripped and the earth ploughed, and then pounded down.

During the ensuing week, there were several storms similar in their formation, and all accompanied with vivid lightning, heavy thunder, hail and rain, but of much less severity than the one described.

After this peculiar series of storms, there were no marked in-

stances of storms of this character until 1872. August 14th, of that year the town of Sheffield, Vt., was visited by a local storm of great severity. From the oppressive heat and calm of the morning clouds rapidly formed and hanging stationary overhead the storm between nine and ten A. M. burst upon the place.

This storm was of much greater extent, covering a section of country five or six miles in diameter. These clouds continued to send down their deluge of rain and hail for three hours. Small brooks were changed to streams ten or twelve feet deep. The bridges were all swept away. The lightning struck several times and several farms had fields of acres in extent washed away, and other land was covered by the débris to the depth of six or eight feet.

In the central part of the storm the wind blew in gusts from all points of the compass, and outside of the storm the wind first set towards the cloud from all points; then from it, as before described, seeming very cool. During the afternoon, showers spread about the country in all directions, but in usual form and not of unusual severity.

Sept. 8th, a similar storm came directly under my observation in the northern part of Lunenburgh. Though of great violence one mile north of my place, I was enjoying sunshine. As in other cases, it seemed to form overhead and remain stationary. The weather as before described. No perceptible wind but vane pointing southwest. At the first formation of the cloud, the wind set towards it in a steady breeze; then from it cool and gusty. In the area of the storm the rain and hail fell in torrents and the darkness was almost like that of night.

Having been led, by former observations, to know what I might expect, I was on the ground almost as soon as the rain ceased. I found fifty rods within the storm the roads washed out so as to be impassable, and leaving my horse, I walked where water would permit. The apples and most of the leaves were knocked off the apple trees by the hail though the hail stones were not large. Grain not harvested was spoiled. Lightuing struck but once within the area of the storm, though the flashes were described as incessant. Everything showed a great waterfall though it was nowhere measured; around the skirts of the storm the wind was cool and outward blowing quite a gale for several miles. A portion of the storm cloud passed off to the southwest, showering moderately.

These of course are marked instances, yet many have noticed a tendeney to first an inward and then an outward wind in hard showers, while those passing rapidly over the country, as the saying is, pass against the wind. It however shifts a few minutes before the rain falls. After a shower has passed, it frequently leaves a delightful cool breeze blowing from it. At the sides of those showers, however, the wind is fitful and gusty, seldom blowing direetly to or from them.

I respectfully present these facts for consideration, hoping that others may observe them until the theory of hail storms and loeal showers of great severity is better understood.

I give no theory but let the facts stand out for consideration as to whether they may not lead to a better understanding of the formation of such storms.

[Printed at the SALEM PRESS, Nov., 1873.]

AN ADDRESS

UPON

FARM PESTS,

INCLUDING

INSECTS, FUNGI, AND ANIMALCULES,

DELIVERED AT A MEETING OF THE

NEW HAMPSHIRE BOARD OF AGRICULTURE,

BY

HIRAM A. CUTTING, A. M., M. D.,
STATE GEOLOGIST OF VERMONT.

MANCHESTER, N. H.:
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1879.

PESTS OF THE FARM,

INCLUDING INSECTS AND MICROSCOPIC FUNGI.*

BY DR. HIRAM A. CUTTING, LUNENBURG, VT.

INSECT PESTS.

It seems proper, as an introduction to the study of farm pests, that I should say something of the general nature of the objects of which I speak. As I first speak of the visible pests called insects, I will define them. Perhaps it would seem almost superfluous to define the meaning of the word "insect," yet I seldom find among the young a perfect understanding of the classifications of life as found in the animal kingdom. This kingdom is divided into four great classes: —

1. Animals of all kinds that have back-bones, or "Vertebrata," and then again they are subdivided into four classes; viz., mammals, birds, reptiles, and fishes.

2. Animals made up of segments or joints, "Articulata." These are again subdivided into —

"Insects," a term from the Latin that signifies "cut into," which expresses that peculiar segmented form. They generally have six legs when adult.

"Arachnida," as spiders, mites, etc., having eight legs.

* This lecture was illustrated by nearly two hundred colored drawings, two by two and one-half feet in size, several of which have been engraved for this work.

"Crustacea," as crabs, lobsters, etc., with from ten to fourteen legs.

"Myriapoda," as thousand-legged worms, or those having more than fourteen legs.

"Annelida," or true worms without legs, as the earth-worm.

3. Animals with soft bodies, called "Mollusca." These are without distinct joints, and have no internal or external skeleton.

4. Animals that radiate from a central point like stars, called "Radiata."

But we will return to our special class. Insects are further known by having their bodies divided into three distinct parts, as follows: The head, containing the organs of sense; the thorax, which bears the organs of locomotion; and the abdomen. They also undergo a series of molts or changes, and usually exist in four distinct stages, known as the egg; next as the "larva," or masked or hidden form, usually so unlike as not to be known by its appearance, though an active stage of its life; then, as the "pupa" or "chrysalis," which is an inactive state; and lastly, as the "imago," or perfect and usually beautiful insect.

To sum up, an insect is a thirteen-jointed, six-legged animal, divided into three distinct parts, as above described, and may be with or without wings; with an external skeleton, and undergoing transformations, breathing through little breathing-holes in its sides, known as "spiracles," which lead to air tubes, answering to our lungs, and known as trachea.

This short explanation shows how we may best prepare ourselves to fight this common enemy. If we can in any way stop their breath, by dust or any viscid substance that stops the spiracles by filling them, we drown them as we would drown in water. With many, this method is very effective, as breath is much more necessary than food. In fact, to the adult insect food is not always necessary, while breath ever is.

But our insect is further classified: —

1. "Hymenoptera," meaning clear or membrane winged, as flies, bees, etc. Some insects of this order have mouths fitted for biting and sucking, with a complex structure, as the honey-bee.

2. "Coleoptera," meaning sheathed or covered wings. These are known as beetles, and go through a complete transformation. The "Colorado potato-bug" is a beetle of this class.

3. "Lepidoptera," meaning scale wings, or wings with microscopic plumage, as butterflies and moths; transformations also complete.

4. "Hemiptera," or half-winged. The insects of this order are known as bugs. Some have no wings, or only rudimentary ones, while others are winged and feed upon plants only.

5. "Diptera," meaning twice-winged or two-winged. This order is very troublesome to man, and is found everywhere upon the earth's surface where inhabitable; the mosquito, gnat, wheat-midge, cabbage-maggot, onion-maggot, etc., belonging to this order.

6. "Orthoptera," or straight wings, meaning straight-winged insects, including grasshoppers, locusts, etc.

7. "Neuroptera," or nerved-winged insects, their wings resembling net-work, as the dragon-fly.

Many of this order are beneficial, and few really injurious, to man.

The time was when any person that attempted the study of the insect world was derided and laughed at; the derisive term of "bug-hunter" was applied to him, and every person supposed that to run after and catch bugs was the insane idea in his life.

More than a century ago, the Swedish authorities became greatly alarmed at the fearful destruction of the timber in their dock-yards by a minute boring-beetle. They at length applied to that renowned "bug-hunter," Linnæus. He told them that the perfect beetle, that laid the eggs for the borer, only appeared in the month of May, and if they would submerge their timber that month, they would be free from its ravages. The government did this, and by this simple and inexpensive method saved their timber, and at the same time brought the "bug-hunter" into respect as an entomologist, a term from the Greek, meaning "one who discourses upon insects," or treats of them and their habits.

In Prussia and Germany the rudiments of entomology are

taught in their common schools, and I would ask if, in a country where the damage from insects is variously estimated from one hundred million to one billion of dollars per annum, and the extermination of insect pests becomes almost imperative, it is not worth while for us to look about us for the necessary information to intelligently fight our foes?

In a letter before me, I am asked, "What is science good for, if scientific men are baffled by one little insect which they cannot devise means to exterminate?"

Science is not baffled, but, like Hercules in the old fable of the Wagoner, can help you and will help you, only when you help yourselves. I may now hear you ask, How may we help ourselves? or, How can New Hampshire alone help herself? We may safely calculate that the insect ravages in New Hampshire for one year will exceed three millions of dollars. Now is it too much to say that a concerted action on the part of all agriculturists would decrease this damage one-half? Did science have full control of our legislatures, law would require and enforce the necessary concert of action; and while agriculturists would groan under imaginary tyranny, they would reap the reward. As agriculturists control the legislature, ought they not to take their best interests under consideration, and do something for themselves?

Concerted action is the only way to combat insect foes, and the law must protect this concerted action from the thriftless ignoramus that don't care for himself or neighbors. The fact is, that the ravages of hostile insects represent a condition of war, and it is only by organization, and appropriate weapons, that they can be conquered. The proper subjects for consideration are the materials to be used, and the best time to make the attack in force, and the weapons to be employed. It is entirely useless for us to fold our arms and exclaim, "It is the will of God!"

It is to lead the farmer to realize his position, and to show him how easy it is to study natural history for his personal benefit, that I presume to stand before you to-night. I will first introduce to you the ten-lined potato-beetle.

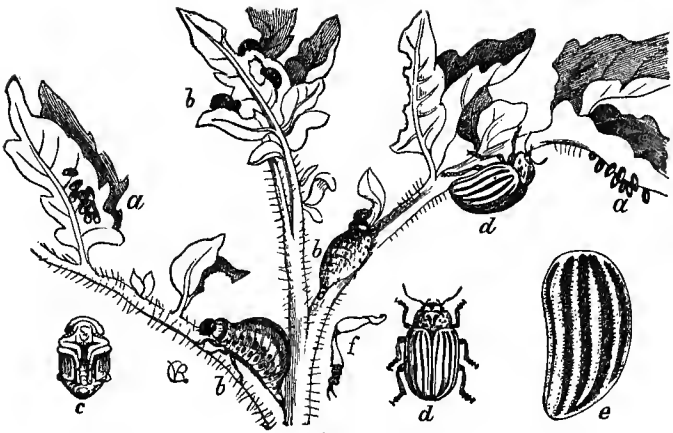

Fig. 1.

TEN-LINED POTATO-BEETLE,—COLORADO POTATO-BEETLE.
Doryphora Decemlineata. SAY.

a, a, eggs; *b, b, b,* larvæ of different ages; *c,* pupa; *d,* perfect insect; *e,* right wing-cover enlarged; *f,* leg enlarged.

This bug, so called, is, strictly speaking, a beetle, and is known to naturalists under the name of *Doryphora decemlineata.* It was first described by Thomas Say, who was then with Long's exploring expedition to the Rocky Mountains. The specimens from which his description was written, were collected in the region of the upper Missouri, and it was found there quite common. Its food in its native place was the wild potato, so common to this mountainous region.

As civilization advanced toward this far western section, carrying the cultivated potato within its reach, this insect acquired the habit of feeding upon it; it even seems to thrive upon the cultivated potato better than upon the wild ones, and, as a result, its numbers vastly increased. In 1859, it had spread eastward to a point one hundred miles west of Omaha city, in Nebraska. Prof. Riley says that in 1861 it had invaded Iowa, and during the next four years it had reached the Mississippi River. In 1864 and 1865, it crossed that river, invading Illinois, from which time it has gradually but surely spread over all the Middle and Northern States.

The first account of its destructive propensities was published in the *Prairie Farmer* for August 27, 1861. From this time until the present, frequent reports and descriptions have been published.

In 1874, it was found upon the sea-coast in New Jersey, but it was in 1876 that the advance guard invaded New England.

Like other higher species of the Coleoptera, it passes through a complete metamorphosis, but, unlike many other beetles, it confines itself during its entire life to the same species of vegetation, and, unhappily, selects as its first choice the potato. This beetle, however, is not, like many of our pests, an importation, but an original native, of the Far West. Its name would indicate Colorado as its birthplace, but historical facts, as I have before stated, would indicate upper Missouri. Yet Prof. Riley thinks it also existed in Colorado. It, however, seems true that this beetle committed severe depredations in Nebraska and Kansas before it was ever seen by the farmers of Colorado, and when it infested that section the people there considered it of eastern origin; but its exact birthplace does not matter.

That it is a great lover of the potato-plant is certain; yet it can exist upon other food when potatoes fail, but first selects the tomato and other plants nearly allied in properties to the potato-leaf; but such plants are seldom attacked until the potato-fields are fully devastated. The eggs of this beetle are deposited, to the number of seven or eight hundred, by each female, at intervals during from twenty-five to forty-seven days, on the leaves of the potato, in regularly arranged clusters of from twenty to sixty eggs each. They are of an orange color, and always on the under side of the leaf. In a week after they are deposited they hatch into larvæ, which feed upon the foliage about two weeks, though some fix the period at seventeen days. When full grown they descend to the ground, where they change into a pupa state near the surface. The perfect beetle appears in a little less than two weeks, pairs when about one week old, and a week later commences the deposit of eggs, as before described. From two to four broods may be hatched in a season. The statements of the time are, however, liable to vary, being longer or shorter, according as the weather is more or less favorable to their development.

The mature beetle, as its name indicates, has ten lines of black lengthwise of its wing-covers, five on each side, the ground being a medium yellow. It has several black spots upon its head and thorax, also six legs, and pink gauze wings under the striped wing-covers. It passes the winter in the perfect beetle state, burrowing in the ground beneath the frost, coming out in the spring, just in season to lay its eggs on the young potato-plant.

The statement is sometimes made that the mature beetle does not feed, and that they infest the potatoes as soon as they break through the ground to lay eggs only. This is untrue. The beetles do feed, not as ravenously as the larvæ, but coming upon the young plant just as it breaks ground, it has little to eat to spoil the crop, and if in abundance it will certainly do so, as the crop of larvæ from the eggs come on so soon that what they leave is at once appropriated by them. It is at this stage of the crop that the farmer needs to be on the alert; though more numerous later in the season, when the tops are mature, they do very little damage.

Bad as these beetles are, they are not as bad as popular opinion makes them. Their first onset is the most severe, and farmers accustomed to give up to imaginary evils will talk about the extermination of the potato. Of that there is no danger from this cause. In Iowa, in 1870, the beetles were very abundant, so much so that they swarmed over barns and outhouses, and also entered dwellings so that you could hardly sit down or walk without crushing them; yet the crop of potatoes was the largest ever known, and they were retailed in the streets for twenty-five cents per bushel. This abundant crop was raised by every one planting in anticipation of high prices, thus bringing the opposite result.

By some this beetle is considered poisonous, but from no just cause, as it can be picked from the potatoes day after day, by whole families, with no bad results. Large quantities of them in a state of putrefaction, like all other animal matter, are disagreeable, and doubtless unhealthy, and they should never be left to putrefy, but be burned or destroyed with boiling water and then buried. As they are voracious feeders, they may be

killed with poison like Paris green, mixed with flour, and dusted on the potato-leaves. A much better way is to brush them off into a tin "catcher," made on purpose, to encircle half the hill.

We have much in New England to favor us in our persecution of this pest, by way of its natural enemies.

Fig. 2.

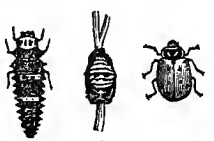

Fig. 3.

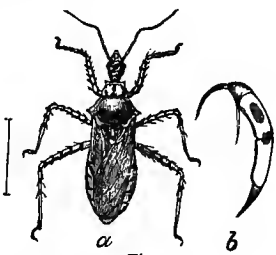

Fig 4.

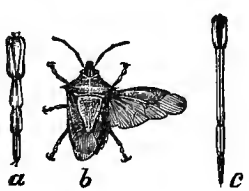

Fig. 5.

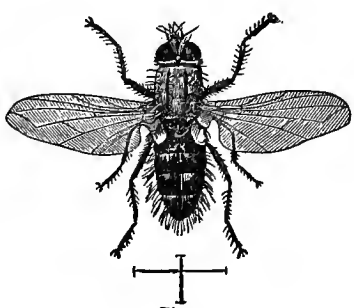

Fig. 6.

ENEMIES OF THE POTATO-BEETLE.

The lady-birds, — *Coccinella* 9-*notata* and pupa (Fig. 2), *Hippodamia* 13-*punctata*, larva and pupa (Fig. 3), — destroy multitudes.

The eggs of the lady-birds are very much like those of the potato-beetle in color, but are smaller, and not so many in a cluster, but always laid in close proximity to those of some other insect. As soon as they hatch they commence their war of extermination, and, as they are voracious feeders, they follow it up almost unceasingly. This lady-bird is about two-thirds the size of the potato-beetle when fully grown, of a yellowish red color, with two or more black markings on each wing-cover,

being shorter and more thick-set than the potato-beetle. In fine, they are about the size and the shape of a half pea. (See Figs. 2 and 3.) There are several varieties, but all are the friends of the farmer, and should have special protection.

So of the many-banded robber, *Harpactor cinctus* (Fabr.) (Fig. 4). It is ever actively on the lookout for food, and woe to the potato-beetle that falls into its sharp claws.

So of the spined soldier-bug, *Arma spinosa* (Dallas) (Fig. 5; *a*, its beak); *c*, the beak of the *Enschistus punctipes* (Say), which closely resembles the *Arma*. Doubtless, both species do a great work, as they are wholesale depredators, not alone upon the potato-beetles, but upon many farm pests.

There is also a parasitic fly (Fig. 6), *Tachia*, that not only destroys myriads of the larvæ of the potato-beetle, but also those of many other pests. The marks at the bottom of the cut denote its actual size.

There is also another deadly foe in the *Philonthus*, which Dr. Packard found to creep even into his hatching-cases and kill not only enough for food, but all; just as the weasel or mink will kill more chickens than they need for food. This beetle is black, with short wing-cases, and is, perhaps, the most terrible enemy of the Colorado beetle. It is a member of the family *Staphylinidæ*.

There are, perhaps, no natural enemies that will entirely kill them out, and so, like the farmers at the West, we are inclined to Paris green. It is, however, much more dangerous here than there. All know it is a deadly poison, and not rendered inert by being eaten by the beetles. Showers wash it from our hillsides, together with the dead beetles, into our streams, where it kills the fish and doubtless poisons the water, so that cattle are more or less injured by it. On level land it can be used with much greater safety. If used at all it should be dusted on the leaves when wet with dew, while the beetles are in their larval state, or mixed with water at the rate of one tablespoonful of the green to a pailful of water. When applied dry it is better to mix with ten parts of flour, by weight; and great care should be taken not to inhale the dust, as it is very poisonous. When in solution it must be almost continually stirred, or the green will sink

in the bottom of the sprinkler, as it is not soluble in the water.

Prof. Riley, of Missouri, says that quite as good results may be obtained in using the ingredients from which green is made as from the finished article. The Paris green costs, say thirty-seven and one-half cents per pound, and the demand is often so great that it cannot be obtained just when wanted, especially in back towns. The following directions for making green, from Brande's Chemistry, are practical: Dissolve two pounds of sulphate of copper (blue vitriol, costing fifteen cents per pound, or thirty cents) in a gallon of hot water, keeping it in a stone jar. Dissolve in another large jar, one pound of common white arsenic (costing about six cents) and two pounds of saleratus or pearl-ash (costing sixteen cents) in forty-four pounds of hot water, stirring well till thoroughly dissolved. These articles, costing fifty-two cents, will make about five pounds of Paris green, which would cost $1.88.

This can be kept in solution and mixed in proportion of one part of the first and five of the last solution, as they are needed. The green immediately begins to precipitate in a fine powder, and is much more convenient for use in solution than the dry article. Prof. Riley says that Paris green can be in this way used without danger; and all agree that in solution, or mixed with flour when dry and dusted on, it is the unfailing remedy.

Dr. Leconte advises the use of large atomizers, for not only the destruction of the potato-beetle, but of all insects that can be killed by a solution. This idea is worthy of consideration, and it may doubtless prove invaluable.

When this beetle first came among the farmers, all birds, like themselves, were suspicious of it, and it has often been reported that no bird would touch them. Such is not true. Ducks will devour them greedily. Turkeys and all fowls soon learn to like them for food, and chickens frequently take them in preference to any other insects. The crow not only takes the beetles and larvæ from the vines in great numbers, but late in the season digs for the beetles in the ground, and captures thousands of them. The rose-breasted grosbeak and many other birds have also a great liking for them. Skunks, toads, and snakes, even,

prey upon them ; then our winters are more severe than the winters West. Jack Frost creeps deeper into the ground, and must overtake many of the ten-liners that supposed themselves safe from cold.

Fig. 7.

Fig. 8.

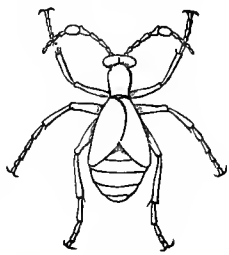

Fig. 10.

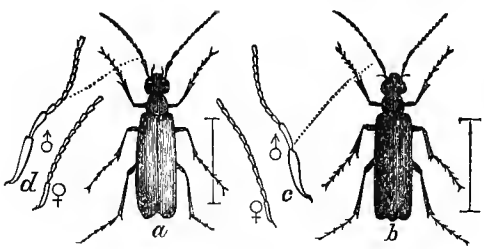

Fig. 9.

THE BLISTERING BEETLES. *Cantharidæ.*

These beetles are also great eaters of the potato-plant. For several years they have done great damage in New England, but only in special localities. They have not become general. Those most injurious are the striped Cantharis, *Lytta vittata* (Fabr.) (Fig. 7), the margined Cantharis, *Cantharis marginata* (Olivier) (Fig. 8), the ash-colored Cantharis, *Lytta cinerea* (Fabr.) (Fig. 9, *a*, male), and the black Cantharis, *Lytta marina* (Leconte) (Fig. 9, *b*) ; *c* and *d* show the magnified antennæ of the male and female, rendering it easy to distinguish them. These beetles, while they will make short work of the potato-leaves, when abundant, are not very fastidious about their food. They will eat beets as soon as potatoes, and also pig-weed, or almost any kind of green leaves when the potatoes and beets fail.

There is another species, being a species of oil-beetle, *Meloe*

angusticollis (Fig. 10), which when plenty are a great foe to potatoes, tomatoes, beets, and various other vegetables; but they are vulnerable to insect enemies, and so are only now and then abundant. They may be killed by Paris green as the potato-beetle, but cannot be picked off, as they are too spry for the fingers.

Fig. 11.

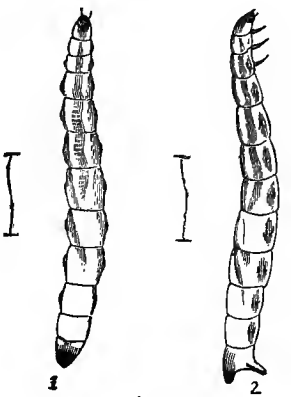

Fig. 12.

STRIPED SQUASH-BEETLE. *Diabrothica Vittata.* FABR.

1. Back view of the grub that eats the root and stalk. 2. Side view; both magnified. The marks show the actual length. Beetle natural size.

This beetle appears on cucumber and squash vines as soon as they are through the ground, and frequently they penetrate through the cracks made in the ground by the swelling and sprouting of the seeds of melons, cucumbers, or squashes, and, biting off the young sprout, destroy the plant before it is out of the ground. These beetles need little description. The cut shows the beetle in outline, and he is well known by the yellowish stripes upon his wing-covers. Their subsequent work, also, when the leaves appear above the ground, is well understood, but the biting off the young sprout, thus preventing the development of leaves, is frequently not known, and the seeds are thought to be poor, or other causes are assigned for their non-appearance above ground.

The gardener watches his plants until he thinks them beyond danger from this beetle, and then is surprised to see them wilt

and die without apparent cause. No wound or injury is found above ground, and so the destruction is looked for in the root. Here we soon discover the true cause of death, for the roots are found to be pierced here and there with small holes. In fact so many are found, that the root presents a corroded appearance. Upon closer examination the authors of the mischief are easily detected, either in the root or lurking in the corroded furrows. They are little whitish worms, about the length of the lines beside the enlarged view of the worms in this figure.

They are, as found, about the thickness of a good-sized pin. The head is blackish, brown and horny, and there is a plate of the same color on the last segment of the worm. These are the young of the beetle, or "striped bug," which was so troublesome on the leaves earlier in the season, and the eggs from which they hatched were laid low down on the stalk at that time. In this masked stage of worm life they do more damage than when in the beetle form on the leaves. When the worms are full grown, which is about a month from the time they hatch, they forsake the root, and retiring to the earth, by continually turning around they form for themselves a little cavity, or minute cave, with solid earthy walls, in which they throw off their skin and become a pupa. This pupa is much shorter and thicker than the worm; they remain inactive for about two weeks, taking no food. At the end of this time they throw off their skin again, and the perfect beetle is seen, still however in a soft condition, incapable of movement. Remaining in its cell till these soft parts have acquired solidity and strength, it breaks through the walls of its little house, and working itself slowly through the soil, appears in the light of day a perfect beetle. We have two generations each year, the second remaining in its dormant or pupa state through the winter. This generation, doing little damage, is not often noticed. Many vines not killed by the worm are so much injured that their value is nearly destroyed.

Covering the vines, with a box covered on top with muslin, has been considered the only sure remedy, though powdered charcoal, lime, and sometimes ashes can be used with benefit. In many cases, however, the material sprinkled on the leaf is as bad as the beetle. If a handful of shavings be burned near the hills

in the evening, many of them will fly into the flames. After various experiments I have become satisfied that covering the hills with common newspapers is much the best means to be used; besides, you get an accelerated growth of the plants. Just as soon as the seeds are planted, or, at any event, a day or two before the plants appear, open a newspaper to its full size, and spread it over the hill, letting it lie close on the ground, and fasten it in place by hoeing the dirt on the edges, so that no gust of wind can disturb it. The plants thus covered will grow at least a third faster than those not covered, are safe from the beetle, and, what is more, safe from the egg that produces the worm, or masked stage of the pest. The plants kept covered until the danger is past are more healthy in every way, producing blossoms several days sooner than those not covered. It is seldom that once covering will not answer all purposes, but should one be torn off from any cause, it can easily be replaced. I have tried different colors of paper, and find white or blue paper best adapted to the purpose. Other colors seem to give a pale green or sickly appearance to the plants. Newspapers are easily obtained, and are just as good as clear white paper. It will be seen, also, that this is a protection against late frosts, and I believe that every person who tries this method of protection will ever use it with entire satisfaction.

TENT-CATERPILLAR OF APPLE-TREES. *Clisiocampa Americana.* HARRIS.

What farmer in New Hampshire is not familiar with the web nests of this caterpillar, glistening in the rays of the spring sun, before the trees are in blossom? Yes, before the leaves are one-half grown, these little white web nests speak volumes. They tell of a negligent, slovenly farmer, whose spare hours are got rid of as useless time, and the pests of his orchard revel in his neglected trees, among which the caterpillar holds conspicuous place. This small white glistening web, if unmolested, soon spreads over several branches, and the caterpillars strip the tree of its leaves, to the great damage of it, if not entailing death, which is ever liable to occur from this cause alone.

This caterpillar is well known to all, yet all do not understand

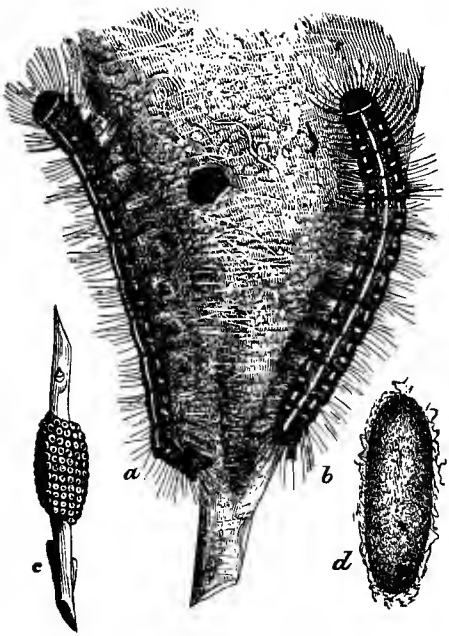

Fig. 13.

All natural size; *a*, larva full grown, side view; *b*, larva full grown, back view; *c*, cluster of eggs on a twig; *d*, cocoon.

Fig. 14.

its habits. The eggs are laid by a night-flying moth (Fig. 14). Its color is a dull, yellowish brown, or something inclined to the reddish tint; it is unusually thick-bodied and hairy. Its wings are characterized chiefly by the front wings being divided into three nearly equal parts, by two transverse whitish or pale yellowish lines, and by the middle space being paler than the rest of the wing, in the male, while it is often the same color as the rest, or even darker, in the female.

Riley says the color is very variable in the Western States. Dr. Fitch notices great variations, but in this section I do not find the variations very great, and think all will readily recognize the moth from the foregoing description.

The moth here described lays her eggs in the night, when she may be found hovering about the tree, in August, or, in the

southern part of the State, doubtless in the last part of July. She lays her eggs in oval rings, round the smaller twigs, as seen in Fig. 13, *c*. These rings contain some three hundred eggs each, and are covered over with a mucilaginous coating which answers the double purpose of keeping out the water, and serving as food for the young when they hatch, to give them sufficient strength to crawl down the limb to the first fork, where, by crawling back and forth, they weave from a spinneret in their mouths the tent in which they live. From this tent they sally forth twice a day for food, eating voraciously. On an average, each caterpillar will eat two apple-leaves a day, and no tree can long live under such a vital drain. As the weather gets warm, when they return from a meal, instead of going into their tent, they go to rest upon the outside, as *a* and *b*. Those coming in later and finding no room, will crawl over the sleepers, spinning all the time, until they are covered, and another story is added to their tent.

Thus from time to time it is increased with their growth, until their food gives out, or their caterpillar life is spent, when they lose their social habits, and wander off to find other food, which they are seldom able to do, or find suitable places in which to spin their cocoons. These are light-colored, with a tinge of yellow, and may generally be found attached horizontally to the under side of fence-rails, or other protected places. They remain in these about three weeks, when such as have not fallen a prey to the ichneumon-fly, as many do, come forth to lay their eggs, as before described. The question so often asked is, How to destroy them? I will first tell you how you ought not. Some flash gunpowder on their nests; others burn them with a torch; while some put on kerosene and burn; and others saturate with oil to kill them. All these methods are destructive to the trees, and should never be employed. Upon a moment's reflection it will be seen that the easiest and quickest way is to cut off the twig containing the eggs.

As they are laid in July or August, there is a long period in which the farmer may destroy them; and as they are found upon small twigs, near the end of a branch, they can be found with a little careful looking, and cut off. After the leaves have fallen,

on a frosty morning the eggs may be readily seen as a dark band on the twigs, as the frost does not so readily adhere to them. When you cut them off always burn them. If this method is neglected, watch your trees when they first hatch, and with a stick remove the entire nest early in the morning, or just at night, — as they feed, and are consequently scattered over the branches, both in the middle of the afternoon and the middle of the forenoon, and some stragglers are absent all day. If they are still neglected, as they should not be, there is no sure way to rid your trees of them but to put on gloves and clean them off with your hands. You can kill by crushing, or have an attendant with a pail of hot water, and put in such branches as you can cut away, or do not crush. Every tent found, whether on orchard or forest tree, should be destroyed.

The black cherry (*Cerasus serotina*), so common throughout the State, is a favorite tree with this caterpillar. If I could have my way in the matter, as they are a useless tree, I would cut them all down, or else pass a law fining the owner of premises where the caterpillars' nests were not destroyed. Concerted action would soon put an end to its ravages; and the thousands of bushels of apples annually destroyed, together with damage to trees for the ensuing crop, would well repay the amount of time and labor necessary for their extermination.

Where apple-trees are overrun, it will feed upon the plum, thorn, rose, willow, common red-cherry, poplar and white-oak, and even sometimes upon witch-hazel and beech trees. But it will ever be found in the greatest numbers upon the black-cherry and apple trees.

FOREST TENT-CATERPILLAR. *Clisiocampa Sylvatica.* HARRIS.

This caterpillar (Fig. 15), the representation of which is a back view, is often erroneously called the "army-worm," and may sometimes be seen in vast numbers, marching along a hard road in the hot sun, or crawling in great numbers along the railroad track. When closely examined it will be found to resemble the apple-tree tent-caterpillar, and is often confounded with that also. The following difference, however, will be apparent: —

Fig. 15.

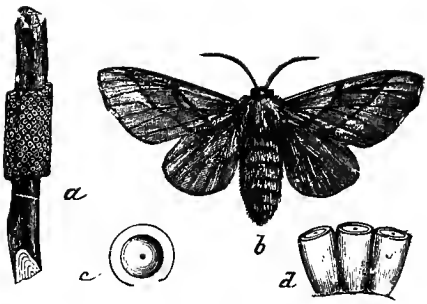

Fig 16.

a, eggs; *b*, female moth, natural size; *c*, enlarged view of egg from top; *d*, enlarged view of eggs from side.

The eggs, as may be seen from the above cut, are distinguished from the common tent-caterpillar by being of uniform diameter in the entire mass, which is docked off squarely at the ends. They are usually composed of about four hundred eggs, the mass being of a creamy white color. These eggs are deposited in circles around the twig, and with each egg is deposited a brown varnish; the second circle is closely fitted into the first, so the eggs stand like rows of cells in honey-comb. In this section, the eggs are deposited in July, or the first of August, the larvæ are quite fully formed by the time winter commences, and the warm days of spring bring them into being, even before there are any leaves on the trees; and it is a singular fact in their nature, that they may not only be frozen, but they actually exist for two or three weeks without food, standing any amount of inclement weather, waiting for the leaf-buds to develop into leaves, which they then eat with hearty relish. As soon as they are born they commence spinning a thread wherever they go, yet as the web is beneath them, close to the bark of the tree, it is often overlooked. They live more or less in company, like the common tent-caterpillar, but go through four successive molts before they arrive at maturity, and at such times huddle in bunches, remaining for a day or two inactive. At their fourth

molt, they quite unwittingly court destruction by collecting in masses upon the trunks of trees, often within a few feet of the ground. After this molt, it may be seen (as before mentioned,) wandering about to find a suitable place to form its cocoon. Why it wanders in such places, and then takes up with a leaf that it can draw together, or several leaves all combined to cover it, we can hardly tell. It, however, frequently spins its cocoons under fence-rails, boards, or any sheltered protection.

The cocoon is much like that of the common tent-caterpillar. Three days after its completion, the caterpillar again casts its skin, and becomes a chrysalis, of a pale reddish brown color, dusted all over with a pale powder, and densely clothed with short and yellowish hairs. In a couple of weeks more, or usually in this State from the first to the tenth of July, the moth issues, being of a brownish yellow, and having two oblique transverse lines across the front wings. It is quite like the moth of the common tent-caterpillar. The most marked difference is, that the transverse bands upon the front wings are darker in this, and lighter in the other species.

There is one noticeable fact about this pest; that is, that for several years we see few, if any, of them, and then there is a year or two of great plenty. The reason of this is, that our insect friends, and we fortunately have many that live upon this caterpillar, gain ground upon it, and come near exterminating it; but, with a dearth of food, they die out also, and the caterpillar then gains again, to become a prey to his persecutors.

By their aid we get along nicely, only now and then a year, when we have to kill them to save our trees. If you jar the tree or branch upon which they are feeding, they will spin down a few inches, and may then be picked off. At their fourth molt, they may be killed as they congregate upon the leeward side of trees, as before noticed; but, as they have already eaten up the foliage, it is not so necessary to kill them as it was earlier, yet always kill them when you can. If you search your trees for eggs in the winter, and destroy them, you will never have much trouble.

When one tree is denuded of foliage the caterpillar travels to another and ascends it. This can be prevented by putting tar

or printers' ink upon a band about the trees not infested. The cocoons may also be sought for and many killed.

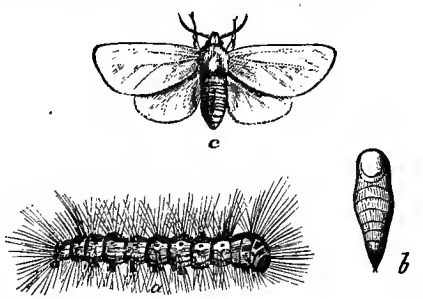

Fig. 17.

WEB-WORM. *Hyphantria Textor.* HARRIS.

All natural size. *a*, caterpillar; *b*, chrysalis; *c*, moth.

One of the most common and destructive of our insect pests is the little caterpillar known by the name of the "fall web-worm," or perhaps more commonly as the "web-worm." The web of this, which at first look seems an insignificant caterpillar, frequently, in the months of July and August, covers the limbs of many trees — a web enclosing leaves seared and dead, from the ravages of this pest. They are more often seen upon elm and apple trees, but other trees are not exempt; and often, towards the end of summer, most of our fruit and shade trees show the ominous web enclosing dried leaves. The eggs from which these caterpillars proceed, are laid by the parent moth in a cluster upon the end leaf of a branch. When these eggs hatch, they are generally on the third or fourth leaf from the end of the twig, as since the eggs were laid the limbs have usually extended their growth to that extent.

As soon as they hatch they begin to spin. To provide a shelter for themselves, they cover the top of the leaf with a close web, which is the result of their united labors. They feed in company beneath this covering, devouring only the upper skin and pulpy portions of the leaf, leaving the veins and lower side untouched. The leaf withers, and they enlarge their web, taking in other leaves, first to the end and then downward on the branch, and taking in other branches, — frequently destroying the entire amount of foliage on the tree.

When fully grown, this caterpillar measures a little more than one inch in length, having a body rather more slender than other similar feeders, very sparsely covered with hairs of a grayish color, intermingled with a few that are black. The general color of the body is greenish yellow, dotted with black. There is a brown-blackish stripe along the top of the back, and a bright yellow stripe on each side. The warts from which the hairs proceed are black on the back and rusty yellow on the sides. The head and feet are black. Of course their age has much to do with the distinctness of the markings, and the adult worm only will be found perfectly marked.

In the last of August, or more generally in the month of September, they leave the trees and disperse, wandering about, eating a little of almost all plants they happen to find in their way, until they find a suitable place for concealment, where they make their thin, almost transparent cocoons, composed of a slight web of silk intermingled with the cast-off hairs from their bodies. If this place is not found they bury themselves just beneath the surface of the ground, where they spin as before, and remain in all cases through the winter in this latitude; but farther south they are said to be two-brooded.

The pupæ are transformed to moths in the ensuing June or July. These moths are white and without spots in New Hampshire, but at the South are said to possess rudimentary spots upon the first pair of wings. The fore legs are tawny yellow, and their feet blackish. Their wings expand about one and one-fourth inches. The antennæ and feelers do not differ from those of other moths; but the females have two rows of minute teeth beneath the antennæ, which is a distinguishing feature.

From the foregoing description of its habits and transformations, it is evident that the time to exterminate these destructive insects is when they are first hatched from the egg, or while but few leaves are involved. This can be done at any time of the day, as they do not go about the tree for food, like the tent-caterpillars, but are always on the leaves covered with the web. If you carefully pick the leaves, it is sufficient; or you can cut off the branch affected, if you choose. In any event they must be destroyed, and the surest and best method is to burn them.

Take a basket into your orchard, gather in it all the leaves on which the web is found, take them to your stove and burn them. Close attention to your premises for a few years will almost entirely rid you of this pest. On no account delay, as, if you do, they will slip through your fingers and very much increase your labors the next season. If they are neglected until they cover more than you desire to prune away, kill as you do the tent-caterpillar.

Some consider this the second brood of the tent-caterpillar, but from the foregoing account it will at once be seen how widely they differ. It hibernates in the pupa state, they in the egg state; it appears in midsummer and fall, they in the spring; its moth is pure white, theirs reddish brown; its eggs are deposited on the leaf and are hatched in a few days, theirs are deposited on the twig, so as to pass the winter on the tree; this feeds solely upon the soft part of the leaf under its web, they devour the whole leaf always on the outside of their tent. It will thus be seen that the only time and best manner of extermination must be as above given.

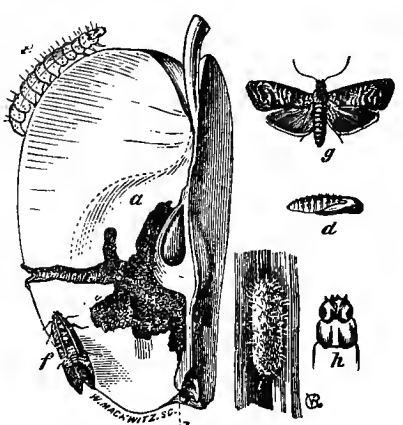

Fig. 18.

CODLING-MOTH. *Carpocapsa Pomonella.* LINN.

a, apple eaten by larva; *b*, spot where egg is laid and the young worm enters; *c*, cavity made by larva; *d*, chrysalis; *e*, larva full grown; *f*, moth with wings folded; *g*, moth with wings expanded; *h*, head and first joint of larva (enlarged); *i*, cocoon.

This insect is, doubtless, found everywhere, where apples are raised. In the month of June, in this State, the night-flying moth comes from his silken cocoon, which was hid under some bit of bark, or sliver, on the fence near by. After pairing, the female may be seen in the dusk of night flitting around the apple-tree, laying her eggs in the blossom-end of the little apples.

There are two broods each season. The first brood is very small, but the second is fifty to one of the first, or even more.

The worm when young is whitish, with usually an entirely black head, and a black shield on the top of the first segment. When fully grown it acquires a flesh-colored or pinkish tint, especially on the back, and the head and top of first segment, as at *h*, become more brown. It is sparsely covered with very minute hairs, which take their rise from little elevated points, of which there are eight on each segment. The cocoon is invariably of a pure color on the inside, but is disguised on the outside by being covered with minute fragments of whatever substance the worm happens to spin to. The chrysalis is yellowish brown, with rows of minute spines upon its back, by the aid of which it is enabled to partly push itself out of its cocoon, when its time to issue as a moth arrives.

The moth is a beautiful object, yet from its habits not being known it is seldom seen in this State ; and the apple-grower, as a general thing, knows no more of the insect that gives him so many wormy apples than he does of men in the moon. Its fore wings are marked with alternate, irregular, transverse, wavy streaks of ash-gray and brown, and have, on the inner hind angle, a large, tawny-brown spot, with streaks of bright bronze or gold. As apples are raised in almost all sections of our country, and wherever apples are raised this insect is a dreadful pest, it becomes us to be well acquainted with its habits, and I shall therefore speak more at length of it than of most other insects.

Riley says, that in Missouri, as well as elsewhere, it is mostly two-brooded ; the second brood of worms hibernating in the larval state, inclosed in their snug little silken home, under some fragment of bark or other protection. The spring weather that causes our apple-trees to burst into blossom, releases this

imago from its pupal tomb, and though its wings are at first damp, they soon dry under the rays of the sun that waked them into their full existence, and they seek their companions. They soon pair, when the male dies, and the female deposits, as before stated, thousands of tiny yellow eggs. As the fruit begins to form, the egg hatches, and the worm develops in the little apple. In from one month to six weeks it has become full grown. Eating its way out, as may be seen in the plate, it leaves the apple, and, spinning its cocoon in some crevice, changes in about three days to a chrysalis, and issues in about two weeks as a moth, same as before, only this time they do not always lay their eggs at the calyx, as they are often found now to enter at the side of the apple. This brood causes the wormy apples in the fall of the year. This second brood always passes the winter in a larval state, either as a worm in the apple, or as a cocoon, and it makes no difference with the time of its maturity whether it goes into its cocoon in September or any time in the fall, or not until spring. Neither does it matter whether it is in a warm room, or frozen, as in proper time, — that is, when the trees are in blossom, — it comes forth to propagate its kind.

Riley says that when in a warm room they are active enough in winter, and will always fasten up any cuts made in their cocoons, though the cuts may be often repeated. These active worms perfect themselves at the proper season, just as well as those that have had a dormant stage, so we may conclude that the dormant stage is not a necessity with this insect.

As this pest destroys millions of dollars' worth of fruit every year, of course it is worth our while to do all in our power to rid ourselves of it. This is a somewhat difficult thing to do, but a great deal can be done to mitigate the evil.

Various authors recommend catching the moth with plates of sweetened vinegar or sweetened water, to be left standing about the trees in spring-time. A few may thus be caught, but at least twenty of our friends may be caught, and usually are, to one of our enemies, so that method is useless.

The first crop of worms, as I have before said, is much the smaller, and as the development within the little apple prevents the full development of the apple, it withers and at length drops

off, usually before the worm leaves it. If this apple could always be destroyed, of course the worm would reap the same destruction. Hogs in orchards in sufficient numbers would do this, by eating all the little windfalls, but hogs are not always at hand. A much better way is to spread a large cloth, prepared for the purpose, beneath the tree, just as the first apples begin to fall, and then by jarring the tree most can be jarred off, and then boil them. This operation, repeated once in three or four days, for, say three times each season, will destroy almost all the first brood, and prevent further trouble that year.

No definite date can be given for this treatment, as some years the season varies many days; watching the fruit, and gathering as directed, as soon as the first signs of exit of the worm can be found, or as soon as they begin to fall, will be sufficient direction.

Another method, as given in the *Country Gentleman*, June 15, 1871, is also valuable. The writer recommends knocking them off with a pole. He says: "Two men with poles usually knock off the wormy specimens about as fast as one boy can gather in a basket." I suspect that this would usually be done too late, as after the worm has eaten its way out of the apple, thus showing the wormy ones, they might as well remain, for the worm is what we want to destroy, not its home. The exudations referred to are not indications of the presence of the worm, but, on the contrary, are sure indications that it is *not* there. I will observe that the gathering of the withered fruit in New Hampshire would probably always need to be in the month of July, and, to do good, must always be before the exit of the worm. If this is not done, cloths laid in the crotches of the branches to shelter the worms and entice them to build their cocoons, wisps of hay or straw wound round the trees, folded or twisted paper bands put around the trees, or any attachment that will afford shelter to the worm and entice it to spin its cocoon, in such a way that it can be destroyed, is beneficial. These bands or cloths, after the cocoons are formed, should be burned, so as to make the destruction sure. They should first be placed about the trees about one month after the tree is in full blossom, and from this time to the time the apples are picked they should

be kept in order, being examined every week, and if cocoons are found they should be at once destroyed, and new bands put in their places, or if but a few they may be crushed, and the old protectors remain.

In a letter received this season, I am asked the philosophy of the hay or straw bands. I can only say, with Prof. Riley, that the straw or hay bands simply afford an enticing shelter for the worm when seeking for a place to build its spun-up house. The hay band is just the thing wanted, as it affords the requisite shelter, and in ninety-nine cases in a hundred will be accepted. There are many patent traps for the same thing, but I am at least safe in saying that none of them are any better than the straw band; many not half as good.

Of the second crop of wormy apples, which are found so often in the barrels that find their way to market, I can only say that a careful examination in early spring of the barrels and the cellar in which they are kept, and the careful killing of all the cocoons that are found, will do much towards preventing the early brood. Though they have a few natural enemies, they are not in such abundance as to allow the orchardist to depend upon them in the least, and so I need make no mention of them.

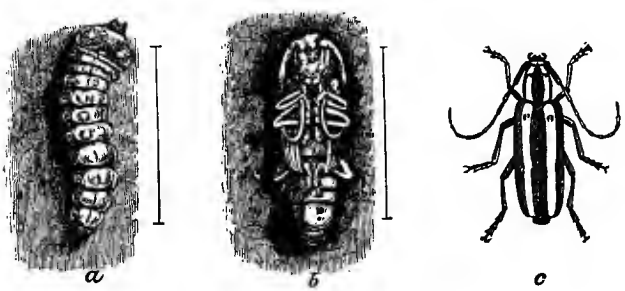

Fig. 19.

ROUND-HEADED APPLE-TREE BORER. *Saperda Bivittata.* SAY.

Figures all natural size. *a*, larva full grown; *b*, pupa; *c*, perfect beetle.

This is a native American, born and bred in the mountains, feeding upon the wild crab, mountain ash, and various other trees. It comes out of the trunk, usually in June, and always by night,

in its perfect state. Resting by day, in the night-time it flies from tree to tree for food and companions. Though they feed upon the bark of branches where it is tender and succulent, they lay their eggs on the bark at the foot of the tree, where the young, as soon as hatched, commence to burrow in the bark. For the first year, they live mostly in the bark, but, towards the last of the season, advance into the sap-wood. Frequently, in young trees, the bark over them will crack and allow their castings to fall out, and thus they may be detected. They remain in the trees three years. As the time comes for their exit, they eat their way to the bark, thin that somewhat, and go into the pupa state, to emerge perfected in about four weeks. Fifty years ago, large, thrifty, long-lived apple-trees were exceedingly common, and were grown with comparatively little effort on the part of our ancestors. This borer in the apple-tree was then entirely unknown to the farmer, and the first specimen ever seen was found and described by Thomas Say, in 1824; and it was not till some time after, that its destructive powers became evident in the apple-tree. Yet it is to this borer, almost entirely, that the short and precarious life of the apple-tree is due.

All understand this borer to be a dreadful pest, but how to deal with it is the question; and to show more fully its habits, and how it may be exterminated, I will briefly review its history. The eggs when laid, as before mentioned, soon hatch, and the tiny worm, differing from the adult in no essential point but size, eats into the bark, and then follows between the bark and wood, sometimes entering the sap-wood low down towards the root the first season. While eating its way in lengthy furrows beneath the bark, the bark sometimes cracks, and the castings of the worm tumble out, revealing its presence. When such is the case, they may be killed with a sharp wire, or carefully cut out with the point of a knife. If left alone they will remain inactive through the winter, to commence their work again early in the spring. The second season they spend mostly in the sap-wood, or near the bark, getting two-thirds their size, and this year doing their greatest damage, as five or six of them will frequently girdle or nearly girdle the tree, making death sure; they again winter low down in the body of the tree, and eat the next

season deeply into the wood, sometimes quite through the tree, finishing its gnawing work at the commencement of the third winter. At the close of its work it extends its passage invariably to the bark, and thinning that somewhat, stuffing the upper end with wood, like sawdust, and below with soft wood fibres, it rests from its labors, remaining motionless as before through the winter. The following spring it casts off its skin, becoming a pupa; rests in this condition about three weeks; and then, as a beetle, gradually gets strength, and after nearly two weeks more, cuts its way through the sawdust piled against the bark, and then the bark, to issue through a round hole as an adult beetle, ready to propagate as before. The time from its entry to its egress, is about one month short of three years.

Few ever take the trouble to hunt for this beetle, and as it flies in the night, lying concealed during the day, it is not often seen in the adult state. As will be seen in the cut, it has two stripes its entire length, and is rather handsome.

There is still another species, called the flat-headed species, as the head of the larva is flat, but, as it is never very abundant and is of small size, it seldom does much harm, and the same treatment is destructive to both species.

The best remedy is to prevent the successful laying of eggs, which may be done by smoothing and then soaping the bark. If such is done near the ground only, they will lay their eggs at the juncture of the largest limbs, or higher up on the trunk, so scraping and soaping must be thorough. If the borers are really in the trees, there is no way except to kill them, or cut them out one at a time. A small piece of whalebone is the best to kill them with, by pushing it into their holes. A piece of wire will answer. When the bark is killed over them it is just as well to cut them out. The application of the soap is necessary in May. Either soft or hard soap will do, but if hard soap is used a thin piece had better be crowded down into each principal crotch of the tree, so that the rain may wash it down the trunk. Do this, of course, after having washed the tree with strong suds.

Fig. 20.

THE CURRANT-WORM. *Nematus Ventricosus.* KLUG.

a, *a*, *a*, different stages of growth; *b*, a single segment of the caterpillar magnified.

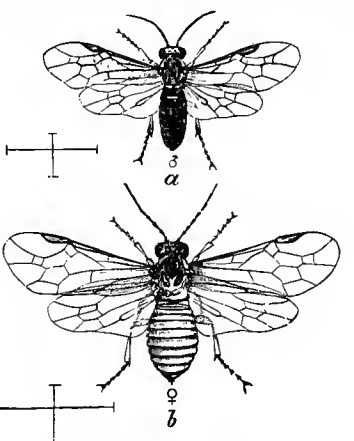

Fig. 21.

Adult specimens enlarged. The marks at the side represent the actual measurement with wings spread. *a*, male; *b*, female.

This worm is so common and so well known in New Hampshire that it needs no description. It affords an excellent example of the wonderful rapidity with which an important insect

may increase and flourish in this country. It was imported from Europe in 1860, into nurseries, in Rochester, N. Y. Since that time it has not only spread eastward throughout New England, but to the Far West. It is a dreadful pest to the currant and gooseberry bushes, and in sections where it has been left to do its work unchecked such fruits are numbered as things of the past.

Though near fifty species of the *Nematus* are natives of this country, this little foreigner has forced himself so disagreeably to our notice that we almost forget the ravages of the native varieties.

Though the worm is so well known, the fly that causes the mischief is seldom noticed. The female is of a bright honey-yellow color. The head is black, with all the parts below, as well as between, the origin of the antennæ, except the tip of the jaws, a dull honey-yellow. The antennæ are brown-black, often tinged with reddish above, except toward the base, and beneath, entirely dull reddish, except the two basal joints. They are four-fifths as long as the body; the third joint, when viewed sideways, is four times as long as wide; the third, fourth, and fifth joints slowly diminishing in length. On the thorax are four conspicuous black spots and other smaller ones. The legs are bright honey-yellow; the hip joints whitish, with the extreme tips of the hind shanks, and the whole of the hind toe joints are blackish brown. The wings are glossy, with dark veins, and expand a little over one-half inch. It is stated in the *American Entomologist*, that in Europe she is known to lay eggs which have not been fertilized, and from them young caterpillars are hatched. It is probable, however, that they do not have the power of again propagating the race, and that the eggs hatch and the worms eat it just as likely as in the case of the silk-worm and other moths, as well as of some insects, including the honey-bee.

The male (Fig. 21, *a*) is rather smaller and is black. The head is dull honey-yellow. The antennæ are brown-black, often a little reddish beneath, except toward the base; they are as long as the body; while longer than in the female, they are also somewhat flattened out. The under side of the thorax and

abdomen are honey-yellow. I have given this minute description of the fly, as, if seen and killed, hundreds of the worms may be saved. The eggs are laid about the 20th of May in New Hampshire, in regular rows, along the under side of the veins of the leaf, at the rate of about two a minute. The embryo escapes from the egg in from four to ten days, and immediately commences feeding. They continue their work upon the bushes until they are bare of leaves, and then, whether fully grown or not, go down into the ground and form little black pupæ, varying in size according to the way the worm is fed. Emerging in about two weeks, they lay their second brood, which pass the pupa state in the ground, as before, but do not emerge until the following spring. The fly lives about nine days.

For their destruction, we first look to the birds. While a few only will catch the fly, none are found to eat the worm. Thus we are deprived of our most powerful ally. We never half realized the good done by insectivorous birds until we have an enemy they disregard. Among the natural enemies of this pest are three kinds of ichneumon-flies, of which one is an egg parasite. From this aid three-fourths of the eggs are destroyed; but the other fourth give us much trouble.

The first method of destruction is to pick off the worms and destroy them. This, if there are but few bushes, can be done quite easily, and is really the most practicable method.

The next in use is to dust on the leaves powdered white hellebore, from a muslin bag. Used in this way, it is not sufficiently poisonous to render dangerous the use of the fruit. This is recommended by Walsh and Riley.

A solution of a pound of copperas to six gallons of water has been used with success. It blackens the leaves, but does no injury to them. Suds made of carbolic soap may be sprinkled on from a common sprinkler. Any dust that touches them is lodged in the spiracles, or breathing-pores, and soon produces death. Dust from the road, dried fine plaster of Paris, or any finely pulverized substance will answer. The Grafton fertilizer, which was finely pulverized quartz, was the best material I ever saw for killing them. It possessed the requisites of great fineness and perfect dryness, so it would make a dust easily.

Gum aloes are, when fine, equally penetrating, and less dangerous than the white hellebore.

By a little attention in time this pest can be easily stayed, by any of the means spoken of, but *The Boston Journal of Chemistry* says this worm can be immediately destroyed by the use of carbolate of lime. This is certainly less costly and more agreeable to use than the hellebore, so to those that must buy something to use, instead of using road-dust, I would recommend it. With two or three applications the work would be done.

Fig. 22.

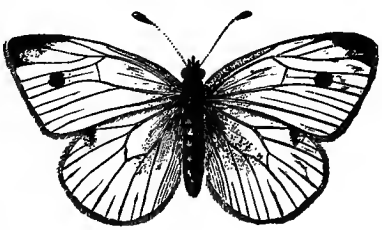

Fig. 23.

Fig. 24.

CABBAGE-WORM. *Pieris Rapæ.*

Fig. 23, butterfly of the cabbage-worm, male. Fig. 24, female. The female is distinguished from the male by having two round spots, rarely three, on the wings. The body of this butterfly is black above, with white wings. *a*, cabbage-worm; *b*, chrysalis.

This worm, the product of the rape-butterfly, is the great pest of the cabbage-grower, and doubtless the worst of all our imported insects. It was imported from England to Quebec in 1857, as it is supposed, with a quantity of cabbages; but it was so sparse that none were seen until 1859, and so rapid was its increase that in 1864 it had extended at least forty miles in every direction from Quebec, and it was estimated that it caused

a loss of the cabbage crop that would have sold for at least two hundred and fifty thousand dollars.

In England and Europe, it is *the* butterfly everywhere common; its larva is the dread of every cook, as she expects to cook several with every cabbage, notwithstanding her utmost care. Its chrysalides are so abundant in the winter-time that they seem present upon everything that affords them the least protection; even upon the doors of dwellings in constant use several may often be found. America had two native species, which sometimes appeared upon the cabbage, but they were content with the outside leaves; but while this important species riddle the outside leaves, they secrete themselves in the head also, and render it necessary to pull the same to pieces before cooking, and then you are not sure, for many times they appear cooked with the leaf. The color is so near that of the leaf upon which they feed that they are ever liable to appear as unwelcome visitants. The use of the cabbage among all is rapidly decreasing from this cause. It has already spread over large sections of the country, being taken in Vermont in 1866, in Maine in 1868, and around New York and Boston in 1870. It is now almost as wide-spread as the cabbage is cultivated.

The butterflies have their bodies black above, with wings white, as may be seen in the cuts.

The female may be distinguished from the male by having two round spots, rarely three, instead of one as in the male, upon the front wings. Underneath both sexes are alike, and have two spots on each front wing, but none on the back ones, which are usually yellowish, yet sometimes with a greenish tint. They vary much in color, but the above general description will be sufficient to enable one to recognize them, as the first impression will be white or nearly so, and the slight variations of tint, from yellow to green, will not be likely to much confuse.

This butterfly deposits its eggs upon the leaves of the cabbage, usually upon the under side. They are exceedingly beautiful when magnified, having a delicate tint, variable as in the butter fly, and seemingly etched with a beautiful network of lines. The larva, as seen in the cut at *a*, is pale green, finely dotted with black, with a yellowish stripe down the back, and a row of yel-

lowish spots along each side in a line with the breathing-holes. As the stripes and spots are somewhat obscure, some farmers do not notice them, and think they have another variety, which is possible, as we have two native species that sometimes feed upon the cabbage, but they are sparse in numbers, and seldom seen in New Hampshire.

When about to transform, it leaves the plant upon which it feeds and takes shelter under the rails of fences, in stone-walls, or any place convenient, and changes to a chrysalis, which, though variable in color, is usually pale green, speckled with minute black dots, as seen at *b*.

The second brood pass the winter in this condition, this species, like our native ones, having two broods a year.

The first remedy that occurs to most when they see their cabbages destroyed, is to quit raising them, and starve them out. This cannot be, as they feed upon several plants, and even upon the willow, when other food is not at hand.

The first method of attack is to cover the young plant with mosquito-netting, held off from the leaves by sticks, usually four of them, set in the ground, and a piece of netting pinned on. This is done in various ways, according to the tact of the person doing it, and, when properly done, prevents the eggs being laid upon the leaves, and so the cabbage grows in security. This costs, besides the labor, from one to two cents for each cabbage.

If this is not done, picking the eggs is the next method. They can be easily found, and, if attended to often, they may all be destroyed. Children can easily do this, and are usually led to do it by the promise of a small reward for any certain number found. When the butterflies are seen about your garden they can easily be caught in a net, as they are slow, lumbering fliers, and easily killed, thus crushing hundreds of eggs without hunting for them.

If the eggs have not been destroyed, poultry, if in numbers, will pick off most of the worms, as they are considered by fowls as a sweet morsel, very desirable. But we can not fully depend upon them to do the work, though they will help greatly. As they get into the very heart of the cabbage-head, hand-picking

will not amount to much more, but yet it will decrease their numbers so that cabbages can be raised.

Paris green or white hellebore will, of course, kill the worms, but should never be used, as it will lodge in the growing head and endanger the lives of those making use of the cabbage. Dust sprinkled on it is also effectual, but will leave grit in the head so as to injure it for eating, yet is without danger.

Carbolic soap-suds are destructive to them, and if not too strong will not injure the plant. Fine sawdust impregnated with carbolic acid is one of the best things for their destruction. Superphosphate of lime, fine salt, ashes, and lime have all been used with effect, yet nothing of the kind is sure to kill all the worms. Close attention to the plant, or perfect protection by netting, as first spoken of, is the only way to secure a crop of cabbages.

If, as estimated, at least half a million dollars' worth of cabbages were destroyed by it around New York City alone, last year, and an average of two hundred and fifty thousand dollars' worth are annually destroyed around Boston, Montreal, and other cities, it shows beyond question, that we have, in spite of our warfare upon it, an implacable foe.

We have thus far but one insect that lends us substantial aid. This is a species of chalcid-fly, and so rapid has been its work that of one hundred and ten chrysalides, collected by F. W. Putnam, of Salem, Mass., at least two-thirds were infested, and brought forth chalcid-flies instead of cabbage-butterflies. In most sections, however, this help has not yet arrived, but will become general, doubtless, in a few years.

By placing boards elevated a few inches from the ground about your cabbages, the worms will select these places for their change to the chrysalis state; and as those infested by the chalcid-fly can be easily distinguished by the livid and otherwise diseased appearance of the body, and left to produce flies, while the healthy are destroyed, you can aid your friends and destroy your enemies. If the chrysalides are all found healthy, you can make a general destruction.

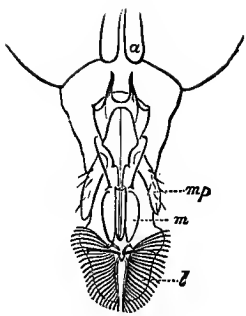

Fig. 25; Tongue.

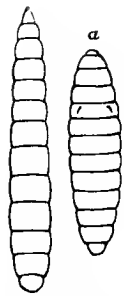

Fig. 26; Larva.

COMMON HOUSE-FLY. *Musca Domestica.* LINN.

This fly, in fact, needs no introduction, as it is well known everywhere, so I do not as much as give its portrait.

There is, however, in the study of the proboscis and tongue-like organ, as seen in the cut above (Fig. 25), much for study. The maxillæ are minute, and their palpi (*mp*) are single-jointed, and the mandibles (*m*) are comparatively useless, being very short and small compared with the lancet-like jaws of the mosquito. But the structure of the tongue itself (*labium*, *l*) is most curious. When the fly settles upon a lump of sugar, or any other eatable substance, it unbends its tongue, extends it, and the broad, knob-like end divides into two broad, flat, muscular leaves (*l*), which thus present a sucker-like surface, with which the fly laps up its food. These two leaves are supported upon a frame-work of tracheal tubes, which act as a set of springs to open and shut the muscular leaves. These, it will be seen from the magnified cut, end in hairs projecting externally. Thus the inside of this broad, fleshy expansion is rough, like a rasp, and so is easily employed by the insect in scraping or tearing delicate surfaces. It is by means of this curious structure that the house-fly occasions much injury to the covers of books, or any polished surface that owes its polish to albuminous material. It is by means of these, also, that it teases us in the heat of summer, when it alights upon the hands or face, to sip the perspiration as it exudes from, and is condensed upon, the skin.

Doubtless all have noticed that house-flies are more numerous

about barns, but few trace the transformation of the fly. Where the house-fly comes from, is often asked, yet seldom answered, as its habits have not been much observed. The barn and its vicinity are usually its birthplace, and about such places may be seen in June, now and then, stray flies, the remnant of last year's brood, that have in some sheltered nook survived in a dormant state the cold of winter. The excrements of the horse are the most desirable on which to deposit its eggs, and yet they may, for want of that material, deposit them on other refuse of the barn, and sometimes even on sand or loam that is made rich by the wash of the buildings. The eggs hatch almost immediately, producing a maggot, fleshy, smooth, and shining, about one-third of an inch in length, and yellowish white (Fig. 26). After feeding for some time it goes into the pupa state, shortening up as in *a* (Fig. 26). It is a reddish brown case, two-thirds the length of the maggot, and, as seen in the cut, thicker and stouter. In this transition case it remains from six to ten days, — according to the warmth of the weather, — emerging therefrom a perfect, full-grown fly. I have frequently called the attention of the farmer to the pupa case, asking him what it was. He almost invariably answers that he supposes them undigested oats that have passed his horse; and in several instances they were dosing horses for indigestion, having taken these pupæ for the signs of such. From inquiry thus, I have concluded that most farmers notice the pupa cases, but do not understand what they are. I have never known the house-fly to lay its eggs upon meat, or anything about the house, though they sometimes do about a sink-spout, or other places where slops are thrown out. With a little concerted action among our population, the house-fly might be greatly decimated in numbers. All barnyard fowls are fond of the larva and the pupa also, and, if yarded where they have full access to their breeding-grounds, will greatly aid in their destruction. As fowls are given to much wandering, they will seldom eat the pupa unless shut up in a yard where the manure from the barn is thrown, or where it usually lies; as the dirt in such locations is rich enough in the necessary larval food to produce them if no manure is at hand.

We will now turn our attention to microscopic pests.

MICROSCOPIC PESTS.

At the present time, every one who possesses any love of nature, or even a love simply for marvelous things, desires some knowledge of the minute mysteries of nature. To follow out the peculiar character of animal or plant when too small singly for the human eye to study, requires a microscope. At the prices they are now sold for, they are within reach of almost every one. With our microscope complete, wherever we search, be it our own dwellings, the meadow or the upland, the grasses or the forest, the ruin crumbling into dust or the sands of the seashore, even in the waters of our marshes, rivers, lakes or ocean, there may be discovered plants and animals which are unknown to our unaided vision, yet endowed with organs perfectly adapted to their respective necessities; and with regard to the latter, often, if not always, for their enjoyment. Even in the aqueous vapor and dust of the atmosphere are germs of living beings, both animal and vegetable, though the latter much predominate, that the microscope alone enables us to contemplate with any satisfaction.

It is true that when near sundown a beam of sunlight struggles through the thick foliage of a forest, or enters our room by means of some small aperture, we can see, floating in that beam of light, numerous particles of apparent dust, yet what its form, or its ultimate destination, our unaided eye could never inform us. It is the microscope alone that gives us aid, and that shows us countless spores, or seeds to reproduce minute vegetation, as well as plants actually flourishing in the atmosphere. Also the germs of animal life are often, yes, very often, there; and, judging from analogy, we find thus an easy method to propagate by germ various diseases in the human family; and that such is often true is beyond reasonable doubt, though such germs have never been fully identified. In our limited survey of those wonders of life and organization, which are thus revealed to us, it is natural to first turn our attention to the vegetable kingdom. And the largest number, as well as the most interesting, of the peculiar plants thus revealed in all their beauty, yet perhaps

the most difficult to understand, on account of their varied appearance and intermediate forms, are the

FUNGI.

Their sudden appearance and growth, their ephemeral nature, and the multiplicity of their forms, have always been a source of trouble to investigators, and even the most indefatigable of modern mycologists have been able to lift but partially the veil which hangs over the life and development of these organisms. Almost every one, however, supposes that there can be no doubt as to what a toadstool, a mildew, or a mold is, and some may even correctly call them fungi, but many others are entirely unacquainted with that Latin word which denotes them. Rust on grain, and smut on Indian corn and other cereals, are also familiar to farmers; but a vast multitude of other all too numerous fungi are known only to the botanist by name, and only to the mycologist in their habits and structures, and to him only after long and patient study. In fact, it is to the researches of many eminent men and women, in Europe, Great Britain, and in this country, both among the dead as well as among the living, that the structure, habits and mode of growth, relation to the various departments of industry, injurious effects and general utility of these smaller fungi in nature, are collected and known. As plants, although of a low order of organization, they are of great interest as mere objects of beauty; but to attain a full comprehension of this fact we must have recourse to the microscope, as the peculiar portions of these structures are beyond the reach of unaided vision. No one that has not had his eye upon them, aided by magnifying power, could possibly conceive that the little specks of brown or black, seen on the brilliant ripening foliage of the maple in September and October, or on the skins of apples, pears, and other fruit; on the dry stalks of plants or straw, on old decaying matter, on the buildings and fence-rails, on the panes of the window, or the bodies of diseased insects, like bees and house-flies,— in fine, on almost everything,— are receptacles of exquisitely sculptured and carved seed-vessels, called *spores*; often beaded thread-like strings of pearls; again,

consisting of myriads of the most fantastic shapes that the genius of man could imagine, but could never imitate.

A subject so broad and so varied, one which can be investigated at any season of the year, inviting the naturalist, more especially the botanist, forth from earliest spring to latest autumn, to search for forms of beauty on every living or ripening leaf and fruit, and in winter rendering the evening lamp more attractive in studying the collected treasures of the summer's gleanings; even if such collections have not been made, the barn with its harvested treasures is at hand, and from that may be taken specimens which can never fail to interest as well as instruct every thoughtful person in some way or other; and would ever be of the greatest interest, if presented in an agreeable manner, and shown with regard to their reference, or connection, with the industrial pursuits of society.

Not only is such study of interest to the botanist, whose specialty is the study of fungi, but it possesses more than ordinary interest to the husbandman whose crops often lie at the mercy of some of this class of parasites, and to his family, as their welfare often depends upon these minute organisms. Even a slight acquaintance with a few of these wonderful little plants, would render the walk for exercise or pleasure ten times more valuable, and often remunerative. Who, even without special thought upon the subject, has not noticed along the roadside early as June, where blackberry-bushes are found among weeds and grass, that their leaves were powdered underneath with rich golden dust, which might be shaken from little orange cups? Many times from children, and often also from the middle-aged and old, has come the query as to what it was. On other bushes also, when yielding fruit, even, to tempt women, men, boys, and maidens; yet would they turn aside, because the dust was ominous, but in what way or from whence it came none knew.

Those dusty-looking lilac-bushes, so dusty ere the close of summer that no rain could wash them clean, or ever will, so long as that peculiar white egg-mold riots on the upper surfaces of their leaves.

The crystalline drops of permanent dew, on some refuse matter, often attract attention as they glisten in the sun, but few stop

to examine and see the white threads in countless numbers that permeate them. Though such things often attract attention, they are soon forgotten when we know nothing about them, and no one is there to tell an anecdote from their history. Cunningly, wisely, and full of secret hidden meaning, a thousand forms of lower vegetable life look up into our faces, while we, with repressed curiosity and not quite willing, tread them under our feet. How few even ever stop to think that they are leaves in the great book of nature, and consequently worthy the reading, and that to every one who will study those pages and translate the hieroglyphics, that the time and trouble of deciphering would be richly rewarded by the knowledge obtained.

"How thankful I am to you," said a friend, "that you have told me so much about the lichens in our pastures. They are now a great source of happiness to me; formerly I detested them."

"The best lectures on botany," said a well-known and highly appreciated educator, "are lessons upon every plant we meet." Yes, within reach of all of us is study for a life-time, and we may thus not only please ourselves, but by and by be considered benefactors. With an intention to introduce a few of these little parasitical growths to the attention of the reader, and to make plain and easy what at first seems so obscure and mysterious, I will bring forward some of the more common species, and, explaining by word and figure their form and habits, endeavor to interest you to such an extent that you will be willing at least to acknowledge their power for good or evil, and know where to find your enemy, when pet plants, or fields of grain, grasses, or potatoes, are likely to fail under the evil so wide-spread and fatal.

CLUSTER CUPS.

M. C. Cooke, the great English writer on fungi, divides them into six families. In one of these families the spores are the principal feature. This family is called the "dust fungi" (*Coniomycetes*). Of course it contains many groups, called families or orders, which are analogous to the natural orders of

flowering plants. Without enumerating any of the various characteristics of these orders, I will select one typical plant. The spores are inclosed in a distinct peridium (covering for the seeds). This is a cup-shaped excrescence on the infested leaves. This order is called *Æcidiacei*. They are always developed on living plants, sometimes on the flowers, fruit, or stems, but usually on the leaves; occasionally on the upper surface, but almost always on the under side of the leaf.

The different species are distributed widely over the entire world. They may be found on every continent, and on almost every island. When examined they look like minute cups upon the leaf, and hence we call them "cluster cups." Besides the generic name they have also added a specific name, generally derived from some plant they are known to infest; but this must not lead the student to suppose that one species is only found on that particular plant, for most of them infest many plants, yet some, of course, to a greater extent than others.

We must therefore look to the actual differences in the fungi, not in the plants they infest.

The leaf may be truly said to be the lung of the plant. Through the stomata (minute holes) on the under side of the leaf, the plant obtains nourishment from the atmosphere, which is as necessary to them as our breath is to us.

Anything that clogs or injures the stomata of any plant directly injures the growth of that plant. This little fungi, when the plant has become infested, breaks through the epidermis, destroying many of the breathing-pores (stomata), and also draws its own nourishment from the life-juices of the plant it infests. Before it breaks through the under surface of the leaf, the infested leaf, if closely examined, will appear to be covered with little elevations or pustules, paler at the apex; these soon become ruptured, and the fungus pushes its head through the opening, at the same time bursting by radiating fissures. The teeth thus formed resemble those of the peristome of some mosses. All around the orifice the teeth, or fringe, become recurved, and the orange spores (fungi seed) are exposed, crowded together within. At first, and in fact while contained in the

peridium (cup), these spores are connected together as a string of beads, but when dispersed they are scattered singly about the orifice, often mixed with colorless cells arising from the partial breaking up of the teeth, or fringe, of the peridium. Let us now for a moment examine the manner in which these cups are distributed upon the leaf. They are scattered without any apparent order over the under surface, with now and then one upon the upper surface, but they nowhere touch each other, unless at the margins of the leaf, but then they are never joined, only crowded. Generally there is a space greater than the width of the cups between them. The leaf is not thickened by their growth, and the upper surface gives you no indication of what is going on beneath. If a leaf be taken fresh, and the epidermis from the under side be stripped off, as it is often easy to do, the orifices through which the fungi have burst will appear in irregular holes, and the fungi will be left rooted still upon the leaf, showing that they are not confined to the surface, and thus we see why the damage is so great to the plant upon which they subsist.

The spores in this species are orange in color, but variable both in size and form, though the majority are comparatively large. Each of these spores is capable of reproducing its species, and if we compute two thousand cluster cups as occurring on each leaf, and many leaves have double this number, and supposing each cup to contain two hundred and fifty thousand spores, which again is much below the actual number, then we shall have not less than five hundred millions of reproductive bodies on one infected leaf, to furnish a crop of parasites for the plants of the succeeding year. As we thus so soon reckon by millions, our figures and capacities fail in appreciating the myriads of spores which compose the orange dust produced from one infected cluster of plants. Nor is this all, for it is found that one of these spores is not only capable of producing a plant, but is in itself a bundle of vegetative spores, which are exceedingly minute, and yet, small as they are, they have the capability to produce fresh crops of cluster cups.

Naturally enough, our reader will ere this be debating in his

own mind how these spores, which we have seen are shed in such profusion, can enter the tissues of the plants which give subsequent evidence of infection, as I have described; in fact, how the yellow dust with which the atmosphere may be filled to-day can inoculate the young plants of next year. If one or two of these spores are sprinkled upon the cuticle which has been removed from the leaf, as we have before indicated, it will be seen that they are very much larger than the stomata, or breathing-pores, which stud the cuticle; hence it is clear they cannot gain admittance there. There remains but one other portal to the interior of the plant, and that is through the extremities of the roots. Here another difficulty arises; for the spores are as large as the cells through which they would there have to pass. This difficulty is, however, much lessened when we remember that these spores are a bundle of infinite particles, each particle of which is probably capable of infecting a plant. Even under this consideration, there is much need of an active imagination, to invent hypotheses to cover the points upon which we as yet know nothing definite.

"The Rev. M. J. Berkeley proved many years ago that the spores of bunt, for example, may be caused to infect all the plants the seeds of which had been placed in contact with them." But this did not prove that the seeds absorbed them, as it is probable they did not, but they would adhere to the seed and thus be conveyed to the ground, where infection to the sprout would be probable. Much has been done to elucidate this mystery, but much remains a mystery still. No spores have ever been seen traversing the tissues of growing plants.

The stems and leaves of violets, sweet-scented and scentless all alike, are often distorted and ruined altogether by a variety of cluster cups; the stinging nettle does not escape; the hardy dock, the useful currant, the wild geraniums, alike feed with their juices fungi of this description.

It has long been a popular belief in England (says F. B. Hough in his report on Forestry), that the barberry-bush (*Berberis vulgaris*) has some agency in the propagation of rust in wheat and other grain, and the researches of botanists have

somewhat tended to confirm this belief. The spores from grain-rust (*Puccinia graminis*) are said to find their way to the leaves of the barberry, germinate, and form cluster cups on the under surface of the leaves, and the spores from these in turn germinate on the grain by alternate generation. The fact that rust sometimes appears in fields where there are no barberry-bushes capable of bearing the intermediate form, appears to indicate that there are other plants having the same capability of bearing the intermediate growth. The clearing off of barberry, or other plants or bushes, near wheat-fields, has, it is claimed, been productive of good results; and if it should be proved beyond doubt that there is a direct relation between this and grain-rust, the use of the barberry as a hedge-plant, as well as that of other bushes, should be discontinued. Cooke, on the other hand, says that while this statement long ago had credit among the people, it has no foundation in fact, as the genera are distinct and perfect in themselves; while some others, perhaps equally eminent, claim intermediate and spurious forms. Professor Œrsted, it is said, has recently determined their *identity* as one and the same plant. In this figure (Fig. 27), *a* shows a leaf of the barberry, with cluster cups upon it (*Æcidium herberidis*); *b*, a portion of the leaf magnified; *c*, the same fragment seen sidewise.

Fig. 27.

The leaves of the pear show other species, and very singular and curious clusters of excrescences occur on the leaves of the apple-tree and mountain ash, and are also very prominent on the leaves of the quince-tree, and especially of the wild apple-tree of the West, consisting of large peridia, pointed at the tops, and so swollen below as to bear a rude resemblance to urns, the edges split into long, contorted threads. They are a

species of *Ræstelia*. The *R. lacerata* is seen in Fig. 28, *a*, natural size, living on the leaves and fruit of the hawthorn; *b*, a portion magnified. The spores are also of a light orange color, but the plant, by comparison, or even by comparison of the cuts, may be seen to widely differ in its appearance. The fir and pine also suffer, as they are often attacked by the *Peridermium*, which changes the foliage, and spoils the effect of their branches, rendering them unsightly. Unfortunately but little is known of this fungus, but it is well worthy of attention from those that are interested in the minute aspects of nature, and those who can recognize the hand

Fig. 28.

> "That sets a sun amidst the firmament,
> Or molds a dewdrop, and lights up its gem."

But we must not stop for reflection, but slightly notice another class. The spores of the smaller fungi have thus far been spoken of as seeds, but this is not strictly true, and several novel and interesting points for consideration and inquiry arise.

If we should place some of the yellow dust, which fills the cup-shaped peridia, in a drop of water, and prevent its evaporation by covering it with a watch-crystal, or any other glass would do as well, we should find in a few hours that each particle of the dust had swollen, and bursting at some point had given out a little thread, at the apex of which it is crowned with delicate curved appendages, which soon become connected by lateral threads, thus forming a kind of latticed network, and from the sides of these filaments little cells sprout, which in turn germinate and reproduce the plant. Those of our readers who are familiar with the early stages of the ferns, can trace a striking analogy in the process.

In many of the smaller fungi the spore is present in another form, constituting what is termed the spermagone (pustules and

depressions like pockets), often in shape of a minute dot near the peridium, and sometimes on the other side of the leaf. In fact it may be like a little blister filled with threads, throwing off little curved bodies called spermatia (germinating filaments), which escape through an orifice provided for the purpose.

Before the nature of these singular objects was known, spermagones were mistaken for distinct kinds of fungi, and many species were thus described. In the *Peridermium Pini*, before spoken of, they are white, few in number, and are developed not only in the spring, but sometimes re-appear in the autumn upon the same leaves that produced them at the commencement of the year. The evident effort of nature, then, in this process, is to produce an ultimate condition of fungal life, which shall be sure to continue indefinitely the presence of the parasites upon the leaves and other parts of the higher plants. And this is done with certainty by the mycelium, a system of the most subtile threads, which can enter the tissues by attacking the seed when sown, and whose persistence of vitality enables it to endure the most trying circumstances unharmed. So vitalized indeed is the mycelium, that any fragment of it will vegetate and grow after long periods of desiccation. And its luxuriance of growth is in nowise dependent on any higher development, such as, were it the stems and leaves of a flowering plant, would be necessary to cause it sooner or later to push forth blossoms and fruit.

This wonderful vitality is taken advantage of in the cultivation of the edible fungi, such as the mushroom for example, where lumps of dry earth permeated by the mycelium, or "spawn," as it is called, are planted in prepared soil and a good crop realized. It is familiar to nurserymen, and all those who cultivate trees for shade or otherwise, that they often languish and die, owing to their roots reaching spots deep in the ground, where decayed wood or other vegetable remains are filled with this subtile fungal spawn, which inoculates the tree with the destructive fungus, causing its death. Fortunately, the awakening and full vigor depends much upon the atmospheric condition, else we should live in fear that every plant would be blasted. From this cause fungi of every form are often regarded

as meteorological phenomena, and wet and foggy weather are complained of as harbingers of various fungoid evils.

MILDEW OR RUST.

Peculiar hot and damp days will be dreaded by nearly all on account of "mildew," but "mildew" is one of those loose terms that represents no definite idea, or a very different one to various individuals.

Talk of mildew of grain to a farmer, and he tells you of the rust which appears in lines or irregular spots upon the wheat-stalk, indicating *Puccinia graminis*, which is known to him and generations before him in many sections as mildew.

Talk to a New England housewife of mildew, and she will describe a minute species of fungus which attacks damp linen, as true mildew, and will ask if you know what will remove the spots occasioned by it.

Ask the hop-grower of New York about mildew, and he will point out a species of mold that infests the hop-vine, but which differs as much from the mildew of the South as does the mildew of linen. The librarian will tell you of mildewed books and papers, and the housemaid of mildewed cellars, — all meaning a fungous growth, but as wide in their significance as the poison-hemlock and hemlock-tree.

Mildew in England means in literature but one thing, and that is the rust upon wheat and other grain, known scientifically as *Puccinia graminis*.

But let us look into the history of this pest. In view of a clearer understanding of this peculiar pest, so long supposed to be several separate species, and which under the present light of science seems fast merging into one, we will suppose a fine day in June dawns upon our resolve to learn of mildew, or rust, and we stray away from the village to gain the chance to examine a wheat-field. Having reached the field, there is no appearance of anything but a healthy crop; we walk into it perhaps fifteen or twenty yards before we find a single fungus of which we are in quest. But let us look closely down at the green leaves at the very bottom of the wheat-plant, and we are soon

rewarded, as we shall find one or two that look rusty. The surface seems powdered with red ochre, and to have grown sickly under the operation. Pluck it carefully, and examine it with low magnifying power; a pocket lens will do. Already the cuticle of the leaf is traversed with numerous longitudinal cracks or fissures, within which and around which you discern an orange powder, to which the rusty appearance on the leaf is due. Further examination reveals also portions in which the cuticle is distended into yellowish elongated pustules, not yet ruptured, and which is an earlier stage of this same disease. This is the rust of the New England agriculturist, the *Trichobasis rubigo vera* of the botanist, or the first phase of the mildew.

To know more of this parasite we must take it to our microscope, and by careful manipulation we shall find that the vegetative system of this, as well as of all similar fungi, consists of a number of delicate simple or branched threads, often intertwining and even uniting one to the other by little branchlets. These threads, as we have before explained, are called the mycelium; they penetrate the intercellular spaces and insinuate themselves in a complete network among the cells of which the leaf or other diseased portion of the plant is composed. We may regard the whole mycelium of one pustule, or spore-spot, as the vegetative system of one fungal plant. At first it might have originated as several individuals, which afterward become combined as one, for the production of fruit, and by their combined effort a cluster of fruit, or spore-spot, is produced.

In the first instance, a number of minute, transparent, colorless cellules are developed from the mycelium; these enlarge, and are filled with an orange-colored endochrome, and appear beneath the leaf as yellowish spots. As a consequence of this increase of bulk, the cuticle becomes distended in the form of a pustule over the yellow cellules, and at length, unable to withstand the pressure from beneath, ruptures in irregular, but more or less elongated fissures, and the yellow bodies, which I will call spores, break from their short pedicels and escape; to the naked eye presenting the appearance of an orange powder.

On the first of August we will again visit our wheat-field. Rusty leaves are more common than before. A little careful

examination, and here and there we shall find a leaf or two with decidedly brown pustules intermixed with the rusty ones. If we remove from the browner spots a little of the powder by means of a sharp-pointed knife, and place it in a drop of water, and cover it with a thin glass, and place it under our microscope, a different series of forms will be observed. There will still be a portion of one-celled yellow spores, but the majority will be elongated, mostly with short stalks, and either decidedly two-celled or a tendency to be so.

These two-celled spores are another form of the mildew called *Puccinia graminis*, which may be produced in the same pustules and from the same mycelium as the rust previously described, and is generally considered at the present time to be the same fungus. Other grain and various other plants are likewise affected.

Fig. 29.

Fig. 29 represents at *a*, wheat-straw inefcted with this rust; *b*, cluster of spores magnified; *c*, single spore magnified 300 diameters.

This rust is so common and so much alike on all plants, that this plate will answer to represent the fungus wherever found.

Let us now for the third time visit our wheat-field. It is ripe, or else much damaged, possibly destroyed, by the fungi.

On the straw we shall find black lines, or blackish spots, from the size of a pin's head to an inch in length; this is the mildew, rust, or *Puccinia*, — it matters not what name it is called, — in full maturity, and when once seen it is never forgotten. Botanists may dispute about its intermediate stages; may give it different names when found on other plants,— but it still remains the great pest of the husbandman. There are no lingering doubts in the minds of agriculturists, botanists, savans of science, or laborers, that the rust is not injurious, because the most casual observation shows it in the sickly condition of all plants affected through the season.

The manner of impregnation is unknown, or, if known, is in

dispute. Some believe, as the stomata or breathing-pores of the plant are open in damp weather, that the infinitesimal germs enter these pores and gain a foothold, and push their rootlets into the cellular tissue of the plant. Others think they enter from the ground through the roots, and others still do not believe that they enter the plant at all, but that the seeds are poisoned by the touch of their spores. Be it as it may, we well know that it exists, and of course desire to have as little damage from it as possible. Observation has shown that rich land, or that manured by old manure, is much more likely to have the grain crop injured than land not so rich, or manured by green manure or some of our fertilizers. This should teach care in the preparation of our land. Some claim that an admixture of sulphur in sowing, and others that if it is sifted on the leaves, is a preventive. Careful experiments have shown all such remedies useless. Ashes are good to produce a healthy condition of the crop, while they have no effect upon the fungi.

The state of the atmosphere conducive to very rapid growth, is usually liable to develop the pest. We believe that all straw infected to a large extent should be burned, and all grasses and weeds standing around such fields should share the same fate. In this way the principal danger might be avoided.

Another instance of the two-formed condition of the smaller fungi can be traced in the delicate condition of moldiness which frequently covers the leaves of the lilac, the grape, the fruit of the gooseberry, and various other plants. It looks like strings of beads made of colorless cells. In this condition it is known and described as *Oidium*.

Fig. 30, *a*, tufts of conidia of the *Oidium Monilioides*; *b*, portion of grass leaf with same species of blight, the spores being the self-same beads and egg-shaped bodies, whence the generic name, but careful observation will show us that this is not its perfect condition; and when, later in autumn, these threads become more compact, and are surmounted on their horizontal surfaces by shining black

Fig. 30.

capsules, or perithecia, each of which is filled with elegant elliptical and elongated cells, and each in turn containing several spores, we shall find in *Erisyphe* that we have arrived at the conclusion of the dimorphism of this fungus, so injurious in its effects.

The famous grape mildew, so destructive to the grapes of Europe, and known as *Oidium Tuckeri*, is also only an imperfect form of some common *Erisyphe*; so of the grape fungi of New England, as well as of various other fungal plants.

Even the cluster cup first described is quite likely to turn out but one form of the rust, on some other plant. Some, as I have before said, even now suppose it identical with the *Puccinia*, and with good reason.

SMUTS.

Another of the fungal diseases of grain, long and widely known among agriculturists, is here called smut. Different names have been given it in different localities. In some it is "dust-brand," in others, "bunt-ear," "black-ball," etc. All the names refer to the blackish, sootlike dust with which the infested and abortive heads are covered. This fungus in New England does not generally excite much alarm among the farmers, yet it often injures the crop. Perhaps it is not so extensively injurious as rust, yet it destroys every infested head of grain upon which it establishes itself, and is also thought to be poisonous to people, or animals, that feed upon it. In Johnson's work on the grasses of Great Britain, he says "that diseased wheat examined by Sir H. Davy, when good, had an average of .955 parts of nutritive matter to 1,000: sometimes from disease, or smut, rust, or mildew, it was reduced as low as .210 in 1,000." The consequence of using such diseased wheat for food would be a step towards starvation, even though no greater evil resulted. It is, however, well known to be highly prejudicial to health; and the higher standard of living among the poorer classes of our population, compared with those of some continental countries, is the only cause of their exemption from the dreadful diseases resulting from the use of bad grain. That such diseases might occasionally prevail among them here, from similar

causes, under a more restricted diet, is evident from a record in the *Philosophical Transactions* for the year 1762. The case in question occurred in the village of Wallisham, about fifteen or sixteen miles from Bury, St. Edmond's, Suffolk, and the report of it was forwarded to the Royal Society by Dr. Wollaston, attested by the Rev. Mr. Bone, the curate of the parish, and is abridged as follows : — Some of the wheat belonging to a farmer in the neighborhood, being laid or beaten down by bad weather, and diseased, the grain much damaged in consequence, it was collected and threshed apart from the remainder. Being unfit for the market, it was sold at a low price to any of the farm laborers, and other people of the village, who would purchase. The sale of this wheat commenced about Christmas, and to one poor family, whose chief and possibly sole support it was for some time, the result was most alarming and unparalleled. It appears that the consumption of this poor wheat by the father, mother, and five children, was about two bushels in a fortnight ; the same being eaten in the form of bread and puddings, both of them very indifferent in quality.

But to poverty, cheapness and sufficiency of food are always irresistible inducements, and this unwholesome fare was continued without intermission until the mother and her children were attacked within a few days of each other with a gangrenous disease. The first indication of the disease was intense pains in the lower limbs. It first occurred on the tenth of January, and was thought to be rheumatism, but when this pain subsided it was followed by numbness and insensibility of the parts which terminated in mortification. The condition of the family at the time Dr. Wollaston made his report to the society is here subjoined : —

" Mary, the mother, aged forty. Right foot off at ankle ; left leg mortified, a mere bone but not off.

" Elizabeth, aged thirteen. Both legs off below the knee.

" Sarah, aged ten years. One foot off at ankle.

" Robert, aged eight. Both legs off below the knee.

" Edward, aged four. Both feet off at ankles.

" An infant, aged four months. Dead."

The father was not attacked until about a fortnight after his

wife and children, and in a slighter degree. In his case the pain was confined to two fingers of his right hand, which turned blackish and withered. Another laboring man in the same parish, who had eaten of this bread, suffered from numbness in both his hands for upwards of a month. They were constantly cold, and his finger-ends peeled; one thumb he says remains without any sensation.

In several instances where bread made from the same wheat was eaten in the farmer's own family, as well as by other persons, no prejudicial effects were noticed, probably in consequence of such bread being used only occasionally, and as an adjunct to other and more wholesome food. The nature of the disease with which the wheat was affected does not appear to have been fully ascertained, but the circumstances are well authenticated. It is of course possible that the want of proper nourishment in the wheat may have had a share to do with the disease; but smutty and mildewed grain has always been considered unhealthy to man, and many cases of disease in animals have often been traced to this cause.

With such examples before us, too great caution cannot be used regarding the use of grain and flour of suspicious character.

These fungi, like many of the others that infest our fields and gardens, belong to the family in which the spores are the distinctive feature, and is regarded as fixed in the genus *Ustilago* (or smut of grain), and the specific name *segetum* (standing). So we have the name *Ustilago segetum*, or the smut of standing grain.

Another kind of smut known in this country is *Ustilago maydis* (the maize smut). It is even more common than the other, as no corn-field is without more or less of it. It forms a peculiar thickened and abnormal growth, that is full of the characteristic black spores represented as magnified four hundred diameters in Fig. 31.

Fig. 31.

The spores in this fungus are very numerous, simple, deeply serrated, springing from delicate threads or in closely-packed cells, ultimately breaking up into a powdery mass. A species of this smut affects some grasses slightly in this country, but in France it frequently affects grass

to such an extent as to produce disastrous consequences on the hay-makers, such as violent swellings of the head and face, with poisonous irritation over the whole system. Threshers are sometimes thus affected in this country, when at work on smutty oats, although not all are equally affected.

The spores of this species are so immense in number, that it would seem impossible to guard corn or other grain against its ravages, but it seems like others of this class — they are quite easily destroyed, and in that way are kept in check. They adhere to the grain in threshing, but if the grain is washed with clean water, and then with a solution of Glauber's salts, and while still moist dusted with quicklime, these spores will be destroyed, and the rust spores also, and the crop will be improved, as the caustic soda is set free by the sulphuric acid of the salts combining with the lime, and converting it into sulphate of lime (plaster of Paris) which is beneficial to the young sprout, while the caustic soda is fatal to the spores of rust and smut.

Other washes, as of chloride of lime, at the rate of one ounce to the gallon of water, or of aqua ammonia in same proportions, are probably also beneficial to kill the spores, and aid germination of the grain. Experience has also taught us that a wet season is much more prolific of fungi than a dry one; and thick-sown grain than thin-sown.

The direction of the wind when grain is sown is of no effect, notwithstanding old people, many of them, think that an east wind is deleterious.

THE ONION SMUT.

This fungus, called by Prof. C. C. Frost, of Brattleborough, Vt., *Urocystis Cepulæ*, since its first appearance in New England in 1870 has caused much damage to that crop. It is thought to be allied to the rust on Indian corn, but not exactly the same. The damage caused to single towns in Massachusetts from this smut alone is estimated at several thousands of dollars. There is as yet very little known about the development of this fungus. It has never been known in Europe, and is supposed to originate from some of our wild species of onions, and of course is as yet

but imperfectly known here. It changes the onion to the peculiar dark sooty powder so well known as smut, and the infected onions at once cease to grow; and though the black may often be peeled off apparently with one or two of the layers of the onion, they are not considered healthy, and great loss is entailed to those raising them. As the spores doubtless remain in the ground, and nothing put on the ground would be likely to eradicate them, the only known help is to change the locality, giving the onions ground on which they have not been previously raised, and using the onion-bed for other purposes, or for such crops as the spores would not injure.

After a time, perhaps four or five years, the old beds might probably be again planted, as doubtless the spores would have lost their vitality.

As this smut at the present time is principally confined to Massachusetts and Connecticut, with a little care on our part, it will be a long time before New Hampshire will materially suffer from this fungi.

Should it appear among us, it should be at once stamped out by burning over the land, and not trying to raise onions on it for at least four years, as a trial would not only be useless but would endanger whole townships by the increase of the spores.

It should as much be the law to stamp out by legal proceedings such pests, as to keep small-pox out of our towns, as the diseases resulting to the human family are none the less to be dreaded because slow and insidious in their workings.

Those who desire to know more of this disease we will refer to the Massachusetts Agricultural Report for 1876–77, where it is fully described.

WHITE RUST.

The idea we have thus far of rust and smut is, that it is dark colored, or like the rust of iron; but as I speak of white rust that opinion must be overthrown, as the white rust of the cabbage, turnip, and all similar plants is one that the gardener has often to contend with. I bring it in to show that fungi must be looked for in every place and under all colors. This white rust

is called *Cystopus candidus*. It is represented in Fig. 32 as it occurs on shepherd's-purse, *a* showing the fruit with the rust upon it; *b*, portions of the cabbage-leaf with the same species upon it; and *c*, conidia of the same. (See Cooke's treatise on fungi.)

Fig. 32.

Upon the leaf of the cabbage it appears as engraved, in white patches; the leaves become deformed and swollen or blistered, even before we can make out fully the cause of the mischief outside. These blistered pustules have a minute system of branching threads, which traverse the pulpy parts of the leaves, and which threads, insinuating themselves between the cells that constitute the pulp, take their nutriment at the expense of the growing foliage.

It is after the pustules assume the white color and are visible on the skin or cuticle that the reproductive parts termed conidia can be detected. (See Fig. 32.) From the multitudes of these beads or spores forming the white powdery dust, the term *conidia* is applied, which means dust-like. Other plants, besides, are often affected, as the water-cress, pepper-grass, radish, and even the weed purslane does not escape its ravages. Its mode of vegetation is one of peculiar interest, in fine one of the most curious phenomena of plant life, and indicates in this low order of vegetation a relation to higher structural forms, not only in plants but even in animals. Thus, if a few particles of the white dust be immersed in a drop of water, and examined under the microscope, they will be seen to rapidly absorb water, and swelling, a large and obtuse papilla resembling the neck of a bottle is produced, and a seeming empty space is formed in the contents of each spore. As these disappear, the whole granular substance becomes separated by fine lines into five to eight por-

tions each, with a small, faintly colored, empty space in the center. These portions are so many zoöspores. These are soon expelled one by one, and soon afterwards begin to move, being provided with seeming fins or fringes by which they are enabled to swim about like an animalcule; but they are only buds endowed with motion, same as many other plants have. These of course are capable of infecting plants, as we have seen.

The prodigal provision of nature is here, as everywhere, especially in its lower orders, signally manifested, when we are told that the immense number of zoöspores capable of being produced from a single infected plant is almost beyond calculation.

It is easy for a million of conidia to be developed from one such plant, each producing five to eight zoöspores. It can scarcely be considered marvelous that the white rust should be so common on plants favorable to its development, the marvel being rather that any escape.

THE POTATO DISEASE.

Mold is a word in common use, and all will tell you what mold is, yet each will perhaps tell you of a different kind. This very numerous family are called *Hyphomycetes*; that is, fungi that grow by throwing out delicate threads.

Of course there are several distinct groups.

To the common eye, unaided by the microscope or observation, mildews, moldiness, and similar microscopic plants would be readily confounded. But the mildew is a much more highly developed fungus, and though apparently as dangerous, is not so to the same extent. The egg-mold (*Oidium*), which covers and suffocates the young gooseberry, or the grape, readily yields to agents which will destroy it, and set free from its threads the swelling fruit; but the potato-mold, for instance, is the inception of the potato-rot, which is so dreaded. The "molds," then, as Russell says, "are fearful parasitic plants, which riot on the tender tissues of other plants and eventually cause their death." There are in this country as many as ten known fungi infesting the potato. It is on this account that those attempting to describe the potato disease have differed so widely from each

other, while all have brought up some facts. The true potato-mold, causing so much mischief, is now generally admitted to be the *Peronospora infestans*, and were it not for its effects it would be regarded as a thing of beauty. Were the flies or insects, which are so liberally endowed with eyes, and quite unconcerned about crops, — to investigate, the leaves of the potato would be quite a pretty set of objects to examine, presenting white, many branched, and beaded twigged plants, with egg-shaped seed bodies on the tips of the branches. These vegetable growths issue from the stomata (breathing-pores) of the leaves, choke up the internal and external passages, and prevent a healthy action from being maintained. Soon the leaves become paler, or yellow, then discolored spots appear, and the stems are covered with dark patches; even the stalks become filled with clotted substances, and sooner or later putrefy, and lastly the tuber suffers, and the rot rapidly increases.

It was towards the close of the summer of 1845 that the world awakened to what they supposed a new disease in the potato crop; and one which threatened its entire destruction. Early in September its ravages in Ireland threatened starvation to the people. It extended to Scotland, England, and the continent, and rewards were offered for detection of the cause; and a host of observations were made with no valuable results.

It is only by long years of patient study that nature's works are found out, and it will be longer still before any sure preventive will be reached. There are, however, some things that tempt this fungous growth that is so destructive; as close planting, damp land, weeds that shade the crop, etc.

As there are some differences of opinion in relation to the actual condition of the potato, favorable or otherwise, to the rot, I copy from the observations of others.

"Some eminent chemists, such as Dr. Lyon Playfair, believe that the potato-plant when healthy, is not subject to attacks from fungi. In a lecture delivered by the doctor before the Royal Agricultural Society of England, December 9, 1845, he remarked that 'much had been said and written with regard to the source of the disease, and since minute fungi had been assigned as its cause, potatoes, apples, and other fruits had been

inoculated with fungous spores, and had become diseased ; but if there was not some previous disease in the potato itself, how was it that some varieties of potatoes escaped while growing in the immediate vicinity, while others were attacked ? ' " The disease, he believed, arose from structural or chemical causes.

When a decayed potato was examined it was found that the diseased spots were always in the region of the spiral vessels whose function it is to carry air into the tissue of the plants. He believed the disease originated in the oxidation of the tissue. The Rev. M. J. Berkeley, the leading mycologist of England, on the other hand, contends that the fungus *Botrytis infestans*, or, as now classed under the new genus, *Peronospora infestans*, will attack the healthy tubers ; but the question arises just at this point, What means have we of ascertaining the perfectly healthy structure, and chemical state of tubers ? Every farmer plants what he deems sound tubers, yet in the majority of cases, since 1845, the crop during very moist seasons has been more generally affected than it was prior to that date.

The severity of attacks of fungi on plants will depend in some cases on the density of their organic structure and the solubility of their nitrogenous matter. The nitrogenous principle of potatoes, for example, is soluble in water ; that of turnips nearly insoluble. The former, therefore, ferments more readily than the latter. The leaves of a healthy peach-tree, when placed in a moist atmosphere at about 75° Fahrenheit, resist fungoid fermentation for months, while those of a peach-tree affected with the " yellows," placed under the same general conditions, will quickly ferment and become covered with the fruit of the fungous mucor. The first possess an antiseptic property, the second are deficient in it. If two blocks of wood, one of boxwood and the other of soft pine, are placed in a fungoid solution, the first will resist the action of the mycelium for a long time because of its density, while the second will quickly decay. The first absorbs very little water, the second a great deal. A certain amount of moisture is always necessary to the growth of fungi. The presence of an excess of water is highly favorable to the growth of the common molds and some other forms of fungoid plants.

In years previous to the noted potato-rot of 1845, the average

amount of water found in healthy potatoes, according to Professor Playfair, was 72 per cent; that of unhealthy tubers since that date, 80 per cent. The tendency to ferment is therefore increased. It was observed by Professor Playfair, in his lecture alluded to, that a peculiar state of the weather had been observed all over the north of Europe where the disease had been seen, as well as in America. The wide-spread use of the potato as an article of diet, especially among the laboring classes throughout Europe, must have led to the extensive planting of diseased potatoes in 1846, because healthy seed could not be found. Indeed, Professor Playfair, in his second lecture of the 10th of December, 1845, recommends "the planting of diseased potatoes as seed rather than none." He further states that there was no prospect of obtaining healthy seed from abroad, and that he had permission of the late government authorities for stating that this was the result of their consular returns. The unavoidable adoption of this advice tended to establish hereditary disease in after years, whether it arose from chemical, structural, or fungoid conditions.

If a healthy potato is so dug out on its opposite ends that it will resemble a double egg-cup, and placed erect on one end for about six days in an atmosphere at the temperature of 70° Fahrenheit, its under cavity will become covered with mildew, and its fruit will appear in the form of blue mold, *Penicillium glaucum.* In this case the inverted cavity will retain the moisture, and as a consequence slight fermentation will ensue, the fungus deriving its nutriment from the potato; but the upper surface, although fully exposed to the floating germs in the atmosphere, will not sustain a fungous growth, in consequence of the free evaporation of the moisture from it. This form of fermentation should not be confounded with that produced by the fungus of potato-rot, *Peronospora infestans.* The chemical action of the blue-mold fungus is slow, and its odor is simply that of sour paste, while the destructive action of the potato-rot is very rapid, producing a higher state of decomposition and very offensive odors. The mycelium and fruit of each fungus also differ essentially from each other. Both forms of fungus produce oxidation of the cellulose structure, but with very different results. Consequently

potato-rot consists of more than the "mere decay of the tissue by its absorption of oxygen." The purely fungoid theory, on the other hand, will not account for the many exceptions pointed out by those who favor the chemical theory; since it may be shown that as the chemical constitution and density of any vegetables vary, so will the genus and species of fungi be found to vary with the proximate principles of the plants on which they subsist.

If there is truth in these remarks, the value of sound, hearty seed is one great preventive. Farmers should therefore exercise great care in their selection, and never plant a diseased tuber. Yet to my mind the fungus is the chief mischief, and so plenty of room, good care, and, I might add, early planting, should go hand in hand with the selection of seed. Russell says entire destruction by fire of all diseased tops should be imperative.

THE BRISTLE MOLD.

One more species of mold, known as the "buttercup-blight," is so common and so peculiar in its growth, that I can not pass it by.

Fig. 33.

a, conceptacle of *Erisyphe communis*; *b*, sporangium of the same highly magnified.

It is represented in Fig. 33. Its varieties are all known as bristle mold, and attack damp paper or books; damp specimens in the collections of our botanists are frequently nearly ruined, and like other fungi they are dreaded pests.

RAPID GROWTH OF FUNGI: YEAST-PLANT.

Yeast is a well-known substance to all housekeepers, but all do not know that it is a plant that thrives on sugar or nitrogenous matter. When the plant is examined under the microscope it is found to be composed of myriads of minute cells, about one twenty-four-hundredths of an inch in diameter. During the progress of fermentation these cells rapidly increase in number,

until all the material necessary to their growth is used up. Its rapid growth, and the evolution of carbonic acid gas from such growth, makes it convenient for the housewife to raise her bread. She prepares her material, puts in her seed, which is some of the spores of the plant either dry or in fluid, and they immediately commence their growth.

The cells grow together in chains, and when stirred they sometimes appear like threads, which are in reality bundles of the fibers of the yeast-plant.

If the yeast is not used in this condition, the plant nourishment is soon used up, putrefaction commences, and with it comes a swarm of animalcules, countless as they are minute, and voraciously devouring all in their way, until they also die from want of food, changing the yeast frequently to a mass of animal and vegetable putrefaction. This soon subsides, and vinegar is the result.

This can be more fully exemplified by milk-yeast, which sooner, as every housewife knows, passes through its various stages, and sometimes is not baked until the putrescence is such as to be hardly endurable to many persons.

With this example of fungous growth before their eyes, who can wonder that the various fungi in the State of New Hampshire alone cost the agriculturist many millions of dollars. They blight his fruit-trees from the seed ; they blight his grain crop more or less every year ; they blight his fruit from the blossom to its end, pursuing it with a determined hate ; they mildew his beans and peas ; they impair his corn and potatoes ; they poison his hay, and disease his cattle ; they destroy his loved ones, often with insidious disease, and then rot out his store-houses, his dwelling, and even fastening upon himself, claim him at last as fit ground on which to ripen their spores for deadly work on others. No pest is so deadly, none so insidious in its workings, none so varied, meeting us everywhere and under almost all conditions. Insignificant in themselves, their very obscurity gives them the best chances to do us injury.

They have their enemies, — countless animalcules feed upon their various forms, yet no family is rendered extinct. The very atmosphere we breathe is often hazy with the spores of various

fungi. The only wonder is, why anything, or any condition of plant or atmosphere, can hold the various families of fungi in check. Some suppose them of spontaneous growth. Why is there need of such a supposition, when their minute spores capable of producing their like cannot even be excluded wherever the atmosphere is present? The wonder is quite the other way, for it is a wonder that they don't destroy more than they do.

ANIMALCULES.

It is but a step from the microscopic plant to the animal. The variety of form peculiar to microscopic life is truly wonderful. It is so different from what we have been accustomed to meet in our visible world that we are at once struck with its peculiar varieties. The number of these creatures exceeds all human calculation. In every pond and ditch, and almost every puddle, in vegetable infusions, in paste and vinegar, on honey, sugar, and all sweet substances, on almost every leaf and flower, even on those fungi only visible through the microscope, and in rivers, seas, and oceans, these creatures are found in such numbers and varieties as to almost exceed belief.

> "The shapely limb and lubricated joint,
> Within the small dimensions of a point,
> Muscle and nerve, miraculously span
> His mighty work, who speaks, and it is done,
> The invisible in things scarce seen revealed
> To whom an atom is an ample field."

Of these wonderful creations, I will only bring forward a few examples.

THE MITE FAMILY.

Comparatively few naturalists have studied up the habits and peculiarities of the mite family. But few of our readers in natural history text-books learn from their pages anything definite in relation to them, either regarding the affinities of these humble creatures, their organization, or frequently singular meta-

morphoses. We shall, therefore, only mention a few typical forms which we have had the pleasure of examining.

Mites are lowly-organized *Arachneds*. This order is divided into four families; viz., the scorpions, spiders, harvestmen, and mites; the scientific name of which is *Acarina*. They have a rounded oval body, without the usual division between the head and abdomen observable in spiders; the head, thorax, and abdomen being merged in a single mass. When mature, there are four pairs of legs, and the mouth part consists, as seen in the adjoining figure of a young tick, of a pair of maxillæ (*c*), which, in the adult, terminate in two or three jointed feelers; a pair of mandibles (*b*), often covered with several rows of fine teeth, and ending in three or four larger hooks, and a serrated labium (*a*). These parts form a beak, which the mite can insinuate into the flesh of its host, upon the blood of which many species subsist.

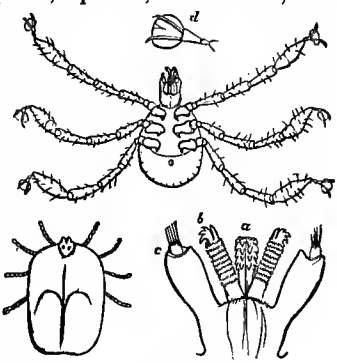

Fig. 34.
Young *Ixades Albipictus*.

While very many of the mites are parasitic on animals, some devour eggs of insects. The *Notherus* (Fig. 35) destroys millions of the eggs of the canker-worm, and it is said that it also sucks the eggs of the chinch-bug.

A few of this species are injurious to man, as the *Sarcoptes*, that burrows under the skin of filthy people, causing a disease once so common, — the itch. The cheese-mites, that swarm over the cheeses in our cities, and sometimes in the country, have six legs when young, but eight after a molt. I have scraped a full pint of them off a single cheese in Boston, and, putting my hand into the mass, I could distinctly feel the animal heat produced by aggregate millions of living, burning furnaces, the same as from higher organizations.

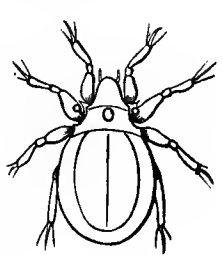
Fig. 35.

The harvestmen, known in this section as "daddy-long-legs," almost always have numerous parasites belonging to the mite family. They also live parasitic on various water insects, and on the gills of the fresh-water mussel.

These species are very minute in size. Some species have been found in the lungs and blood vessels of various animals.

THE SUGAR MITE.

Many people have been startled by statements sometimes read, or that they have heard from authoritative sources, as to the immense number of mites (*Acarus Sacchari*, Fig. 36,) found in unrefined or raw sugar, but those statements generally fall below rather than above the truth.

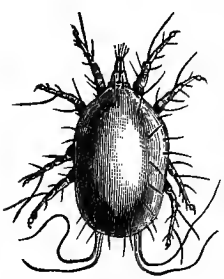

Fig. 36.

Dr. Hassel, who first discovered them, found them upon sixty-nine out of seventy-two samples, and found sixty or seventy mites to one grain of sugar, in most of the samples. Mr. Cameron counted five hundred on ten grains, which would be one hundred thousand to the pound. This would really be quite an adulteration, but, under favorable circumstances, that is, with warmth and moisture, I have seen one-half the bulk, at least, animal life. This would, however, only be the case upon small lots of sugar. When in barrels, their number is frequently immense, but they are much more plentiful at the top of the barrel, or nearest the light, though light is in no way necessary to their production.

The disease known as "grocer's itch," is undoubtedly due to the presence of this mite, which may now and then work its way under the skin of the hand.

Plentiful as these mites are on the damp brown sugars, I have never detected them on dry white sugar, though I almost always find them on figs, dates, honey, if grained, and often on the comb when not; in fine, they may be found on all sweet substances that are sufficiently exposed.

They are a jolly, playful race of beings, and seem to live and eat for enjoyment; when frightened they play dead, curling up their legs, and remaining inactive for some time.

Another singular mite, and of the lowest order, burrows in the skin of dogs, and also in the diseased follicles of the human face, and more especially the nose of man. (See Fig. 37.) It is a long, slender, wormlike form, with eight short legs, though like many other mites it has but six in the larval state. Washing the face in water to which has been added one teaspoonful of strong aqua ammonia to the quart, will usually remove them.

Fig. 37.

WATER ANIMALCULES.

Perhaps no class of objects that are visible to us only through the microscope engage our attention so often, or amaze us so much, as the various forms and peculiar habits of the water animalcules.

For the first time it is an amazing spectacle to view an assemblage of dissimilar forms in a drop of stagnant water. They are from one thousandth to one ten-thousandth of an inch in diameter, and I once saw them so crowded that the spaces between them were not much larger. Several hundred forms have been studied and described, but I shall only mention three or four of the more common species. Remember, while pond or river water will contain now and then specimens, that it is stagnant water alone that is crowded, and the pure spring-water of New Hampshire never contains any animal life.

The motions of these creatures are varied, I might say almost endless, in variety; but amid their diversified gambols all have the power of avoiding obstacles in their course, and their neighbors, which are in such close proximity to them. Some species are far more common than others, but the more uncommon varieties may frequently be obtained in midsummer, by exposing a decoction of any dried leaves to the sun for three or four days; such exposure must be in the open air. A few species I will describe.

The *Rotifer*, or wheel-bearing animalcules, are so termed from the appearance of certain wheels, often seen rapidly rotating in various situations on the anterior part of the body near the

mouth. We say wheels, because they were so considered by early microscopic observers who could not account for the motion in any other way; but an improvement in instruments has shown that it is an incessant muscular action, giving an apparent rotation; but that wheels could revolve in any part of an animate body, would be quite inconsistent with the laws of animal organization. These wheel-shaped muscles are used to aid in the motion of the animalcule and in supplying its food. They are entirely subservient to the power of will, as they can stop the motion instantly or increase it as they choose.

Their body, though so small, in one species, is shielded by a shell into which this rotating apparatus can be drawn at will. It is by the whirlpool, formed by the before-described rotations, that its food is drawn into its mouth as a vortex, where it is masticated by three tiny teeth, and swallowed into a prepared receptacle where it is ground by muscles working vigorously on each other. Minute and curious as these organs are, the animalcule is so small that like all other microscopic creatures they are transparent, and with a moderately high magnifying power this can as well be seen as the workings of a steam engine made of glass.

This species enjoy sunshine, and on dark, cloudy days are only found at the bottom of the pond or ditch in which they reside.

Again another of this same species, called *Tardigrade*, have so great a tenacity for life that they may be put upon a glass slide and dried for days, yes, for months or years, and then at once resuscitated by a drop of water. Dr. Carpenter, one of the most renowned microscopists of Europe, states that their tenacity of life goes even further, as he has kept them in a vacuum for thirty days with sulphuric acid and chloride of calcium, thus causing them to suffer the most complete desiccation that the chemist can effect, and yet they have not lost their capability of revivification. For this reason they have been styled the resurrectionists, and it seems for good cause. This wonderful power of resuscitation, and the fact that the rapidity of their reproduction, as estimated by Prof. Erenberg, being from the egg at the rate of seventeen millions per month, is cer-

tainly sufficient for their remarkable appearance in almost every situation, and under almost all circumstances.

It has been supposed by some that they were the result of spontaneous production, but from what I have said you can see there is no necessity for such a conclusion. The many curiosities connected with the life and introduction of the Rotifer, into almost all places, of course will excite the amateur in microscopical investigation to search for them. That he may not be disappointed, I will state that in the leaf-cells of the Spagnum, generally known as bog-moss, there is a very curious departure from the ordinary type of vegetable growth. Instead of the usual cell-tissue their leaves contain spiral fiber, loosely coiled in their interior, and in the membranous covering of the stem there are nicely rounded holes, or apertures, by which there is free communication with the interior, as well as with each other. These natural caverns are appropriated by the Rotifer, and used as dwellings. It is here you are sure to find them at home.

Another species, called Aurelia, are covered with cilia, or minute hairs around the mouth in a circle; by their agitation animalcules much smaller are drawn into their mouths and devoured.

Again the Hydra, which may be found in ponds and rivulets adhering to the leaves of aquatic plants, or twigs and sticks that have fallen into the water, is a wonder among wonders.

It may be subdivided many times and yet every part will in a few hours become a perfect Hydra. This name is given them because they have many long arms, which were supposed to resemble the heads of the fifty-headed water-serpent, called Hydra, which fabulous history informs us was destroyed by Hercules, in the lake of Lerna. They are by no means vegetarians, and have the capability of swallowing creatures as large as themselves.

In the ordinary mode of multiplication little budlike protuberances are developed on their external surface, which are soon observed to resemble the parent in character, possessing a digestive sack and mouth.

For a time, however, this cavity is connected with that of the parent, but at last the communication is cut off, and the young

Hydra quits its attachment and goes in quest of its own maintenance.

A second generation of buds are, however, frequently seen on the young before quitting its parent, and I have counted as many as eighteen in different stages of development on one original stock. Again, in taking its food, it sometimes happens that the same morsel will be seized upon by two Hydræ, when a struggle for the prey ensues, in which the strongest gains the victory. Sometimes each will begin to swallow the same morsel, until the mouths of the pair come in actual contact, when, if the morsel does not break, the larger deliberately swallows his opponent, sometimes partially, so as to compel the discharge of the food by the smaller, but frequently the entire polyp is engulfed. But Hydra is no fit food for Hydra, and his capacity for endurance saves him from a living tomb, for after a time, when the food is sucked out of his mouth, the sufferer is disgorged with no other loss than his dinner.

Yet perhaps the greatest curiosity is in the reproduction of its parts. Split one open, and the separate parts will soon take food, and in twenty-four hours are as perfect as ever.

Strange as it may seem, all these processes can be watched with unerring certainty, and so interesting are the developments, that I always dislike to close the scene, though aching eyes will at length gain the mastery.

TRICHINA SPIRALIS.

As the *Trichina Spiralis* is an animalcule liable to infest man to his injury, and often a disease of swine, rendering the pork dangerous to the consumer, I have selected it as of peculiar interest. It is a small spiral worm, like a pin-worm, which has ever been found now and then in muscles of various animals. It is supposed by some to originate in the rat, and to have been from them spread over the country as they gained a foothold, as it is often found in their muscles, and frequently in those of cats that devour them. How it comes to infest pork is uncertain, but probably by their food, as a hog is none too particular upon what it feeds, and might eat portions of rats or any other dead animal.

The immature parasites, as seen in muscle under the microscope, are worms about one twenty-fifth of an inch in length, spirally coiled up within globular, oval, or lemon-shaped transparent cysts, which, according to the length of time they have been formed, are more or less covered with calcareous matter.

From various experiments, I have been led to believe that after they are completely covered with this calcareous concretion, sealed as it were in a stone sarcophagus, that they are destroyed; such flesh containing them will not contaminate other individuals, as I have fed young rats with it without effect, when they were always contaminated when fed with diseased meat in which the cysts were not calcareous, though the cysts themselves are to be considered rather as abnormalities, developed some little time after the larvæ have reached their destination, as hundreds of specimens have been seen to co-exist entirely free from cysts.

Fig. 38 shows the Trichina when thus incysted in the muscles (magnified).

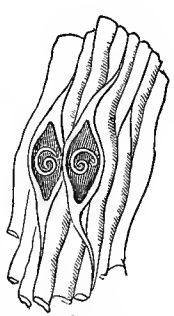

Fig 38.

The number found in any one subject varies, but Leuckart estimated that one ounce of catfish which he observed must have harbored more than 300,000 parasites. Even if we assume that the forty-five pounds of muscle which an ordinarily healthy man possesses were infested with only 50,000 Trichinæ to the ounce, they would still contain more than thirty millions.

Fig. 39.

The adult Trichina magnified is shown in Fig. 39.

The sexually mature male Trichina, according to Cobbold, is about one-eighteenth of an inch long, while the adult female is one-eighth; the body is rounded and slender, and the head very narrow and sharply pointed. The mode of reproduction is viviparous. The muscular parasite, when introduced into the alimentary canal of man or animal, is set free in the process of digestion, and in two days' time reaches the adult

condition. Leuckart states that in six days more the female brings forth a numerous brood of minute, hairlike larvæ; these soon begin their wanderings by piercing the intestinal walls, after which they proceed through the system till they reach the muscles, into which they penetrate; here they develop so that in two weeks more, that is, in about three weeks from the time the infested food was taken, they present the appearance of the ordinary muscular *Trichina Spiralis*, as shown in Fig. 38.

The sexually mature worms probably produce more than one brood of young; they have been found alive in the intestines eight weeks after the infection of the flesh in which they were contained. The larvæ remain in the muscles they have reached, and shortly become incysted as heretofore mentioned. Smoking the meat does not kill the parasites it contains; brine, if very strong and long applied, probably does; thorough cooking certainly does. Time also has its effect on them, though they are endowed with wonderful vitality. In some healthy subjects who died from accident, the larvæ and their inclosing cysts have been found to have undergone calcareous degeneration; but it is probably months, and even years, before death of the parasite occurs; in illustration of which, Virchow states that in one case he found them alive eight, and in another thirteen and a half, years after infection.

When a person is infected, which infection usually takes place from eating partially cooked sausages or raw bacon, in three or four days there is lassitude, depression, sleeplessness, loss of appetite, and fever. Then there supervenes excessive pain in the muscles, especially of the limbs, contractions of the knee and elbow, swelling of the limbs with apparent pneumonia, and frequently mania with death.

On post-mortem examinations, the muscles are found crowded with the parasites, and to be in a state of fatty degeneration. If they recover, after three or four weeks of the same symptoms, with less severity, convalescence commences, and in six or eight weeks more the patient is quite well, and the incysted Trichinæ seem to give him no further trouble. The virulence of the attack seems to depend considerably on the number of parasites introduced into the patient's stomach, yet the previous constitu-

tion and strength of the patient have much to do with final recovery.

The true safeguard is to eat no pork unless thoroughly cooked; yet microscopic examination will reveal the disease, even if ever so small a section of a muscle be examined, and it should be incumbent upon all butchers here as in Germany, to make such examination, and they should be punished here, as there, for selling Trichinous meat.

For this time I will present no further microscopic wonders. What I have said is sufficient to show you, that around us all exist immense fields of study, easy of access, and yet pregnant with wonderful facts, with but few of which we are as yet conversant.

> "Has any seen
> The mighty chain of beings, lessening down
> From infinite perfection to the brink
> Of dreary nothing?"

Until we have, let us be ever ready to grasp truth, wherever found, and lend idle hours to investigation.

BIENNIAL REPORT

OF THE

FISH COMMISSIONERS

OF THE

STATE OF VERMONT,

FOR

1881-82.

POST OFFICE ADDRESS OF COMMISSIONERS:

HIRAM A. CUTTING, M. D., *Lunenburgh.*
HERBERT BRAINERD, . . *St. Albans.*

MONTPELIER:
WATCHMAN & JOURNAL PRESS.
1882.

SENATE CHAMBER,
NOV. 15, 1882.

Laid before the Senate, and, on motion of Mr. HOGAN, *ordered to lie*, and the Secretary directed to procure the printing of 1000 copies for the use of the General Assembly.

A. K. BROWN, *Ass't Sec'y.*

REPORT.

To His Excellency, JOHN L. BARSTOW, *Governor of the State of Vermont :*

HON. SIR :—We, the undersigned, Fish Commissioners for the State, would respectfully report that we have, as far as practicable, looked up the results of the previous stocking of ponds and streams, and also the demands of the people, that we might be the better able to judge in relation to the practicability of stocking ponds and streams as before done, or of using other varieties instead, of fish and spawn as formerly distributed, and also that we might judge understandingly of the wants of the people, as what is done without their concurrence better not be done at all.

It is a conceded fact, established by the usage of European nations, that every acre of water may become more valuable for its product of fish than an equal number of acres of our best land for the products of the same.

It is, however, necessary for the best results that streams and ponds once stocked should not be left without oversight, and the fish be allowed to starve or to be caught by unlawful means ; but that, when necessary, food fish should be supplied to them, that the fish we desire to raise be not forced to prey upon each other or starve ; and that proper protection be offered the law-abiding citizen that the lawless class may not have any advantage that as now enables them all to often deplete ponds and streams in the most wanton manner. Besides the various streams in this State, all of which are capable of yielding many fish, we would specially call your attention to the fol-

lowing ponds, made as correct in name and area as possible from the data in our hands. We would, however, request such persons as notice errors in this list, to notify us of the same, that we may correct as far as possible, and thus have a more reliable data to predicate our judgment upon in the distribution and care of the Fisheries of the State:

Names of Towns.	Names of Ponds.	Area in Acres.
Albany	Great Hosmer Pond	600
Arlington	Duck Pond	75
Athens	Athens Pond	50
Averill	Great Averill Pond	1500
"	Little Averill Pond	1000
"	Leach Pond	600
Barton	Crystal Lake	1400
"	May Pond	100
"	Fuller Pond	50
Barnard	Silver Lake	200
Barnet	Harvey's Pond	300
"	Warden's Pond	100
Benson	Sunset Lake	300
"	Little Pond	100
Berlin	Berlin Pond	650
Bolton	Hinkson Pond	100
Braintree	Mud Pond	75
Brighton	Island Pond	1500
"	Spectacle Pond	500
"	Black Pond	100
Bristol	Bristol Pond	300
"	Gilmore Pond	50
"	North Pond	50
Brookfield	Freeman's Pond	100
"	Colt's Pond	75
"	North Pond	75
"	South Pond	75
Brownington	Brownington Pond	500
Canaan	Leed's Pond	1500
Cabot	Mollie's Pond	200
"	Joe's Pond	600
Calais	Bliss Pond	300
"	No. 10 Pond	350

Names of Towns.	Names of Ponds.	Area in Acres.
Calais	Nelson's Pond	300
"	Curtis Pond	200
Castleton	Bomoseen Lake	10,000
Charleston	Echo Pond	600
"	Pensioner Pond	100
Colchester	Colchester Pond	200
Concord	Mile's Pond	400
"	Hall's Pond	250
Coventry	Memphremagog Lake	8000 in Vt
Craftsbury	Large Hosmer Pond	800
"	Little Hosmer Pond	900
"	Elligo Pond	150
Danby	Danby Pond	400
Danville	Joe's Pond	1000
Derby	Derby Pond	1000
"	Salem Pond	1000
Dorset	North Dorset Pond	250
Eden	Eden Pond	300
"	South Pond	250
"	Belvidere Pond	100
Elmore	Elmore Pond	300
East Montpelier	Hollister Pond	75
Fairfield	Fairfield Pond	3000
Fairhaven	Inman Pond	100
Fairlee	Fairlee Lake	1500
"	Fairlee Pond	600
Ferdinand	Milligan Pond	200
"	New Found Pond	300
"	Trout Pond	75
Fletcher	Metcalf Pond	500
"	Half Moon Pond	200
Franklin	Franklin Pond	2000
Glover	Parker Pond	300
"	Stevens Pond	200
"	Daniels' Pond	150
"	Clark's Pond	75
"	Sweeney Pond	100
Goshen	Dutton's Pond	75
Greensboro	Caspian Lake	3000
"	Long Pond	700

Names of Towns.	Names of Ponds.	Area in Acres.
Greensboro	Eligo Pond	300
"	Mud Pond	75
Groton	Groton Pond	1200
"	Wells River Pond	250
"	Kettle Pond	250
"	Lund's Pond	100
"	Levi Pond	100
Hancock	Dunham Pond	75
Hinesburg	Hinesburg Pond	400
"	Little Pond	75
Holland	Holland Pond	600
"	Beaver Pond	75
Hubbardton	Sunset Lake	2000
"	Horton Pond	200
"	Beebe Pond	150
"	Keeler's Pond	100
Huntington	Gillett's Pond	200
Hyde Park	Green River Pond	300
" "	Clear Pond	100
" "	George's Pond	200
" "	Zacks Pond	100
" "	Mud Pond	75
Harris Gore	Pigeon Pond	150
Irasburg	Kidder Pond	75
Jamaica	Jamaica Pond	50
"	Adams Pond	50
Kirby	Kirby Pond	100
Leicester	Lake Dunmore	3000
"	Little Pond	300
"	Silver Lake	100
"	Mud Pond	100
Londonderry	Derry Pond	200
"	Lillie Pond	100
Lowell	Walker's Pond	150
Ludlow	Ludlow Pond	200
Lunenburgh	Neal's Pond	450
Maidstone	Maidstone Lake	1000
Marlboro	North Pond	500
"	Marlboro Pond	500
Marshfield	Niggerhead Pond	100

Names of Towns.	Names of Ponds.	Area in Acres.
Marshfield	Kettle Pond	75
"	Mud Pond	50
Manchester	Equinox Pond	50
Milton	Long Pond	75
"	Round Pond	50
Monkton	Monkton Pond	350
Morgan	Seymour Lake	5000
Mount Holly	Patch Pond	150
" "	Jackson's Pond	75
Newark	Newark Pond	150
"	Centre Pond	150
Newbury	Hall's Pond	300
"	Round Pond	100
"	Harriman's Pond	100
Newport	Memphremagog Lake	10,000
Norton	Norton Pond	300
Norwich	Tilden Pond	75
Orwell	Smith's Pond	150
"	Sunset Lake	600
"	Mud Pond	75
Peru	Buffam's Pond	100
Peacham	Peacham Pond	700
"	Foster's Pond	150
"	Martin's Pond	150
Plymouth	Plymouth Pond	250
"	Woodward's Pond	150
"	Black Pond	100
"	Reading Pond	100
Reading	Reading Pond	100
Readsboro	Readsboro Pond	75
Richmond	Gillett's Pond	150
"	Richmond Pond	75
Richford	Hill Pond	100
Ryegate	Syme's Pond	700
"	Tickleneck Pond	300
"	Coburn Pond	75
Salisbury	Lake Dinsmore	3000
Sharon	Standing Pond	75
"	Bush Pond	50
Sheffield	Bruce Pond	100

Names of Towns.	Names of Ponds.	Area in Acres.
Sheffield	Duck Pond	100
"	Long Pond	100
"	Round Pond	100
Shelburne	Shelburne Pond	600
Shrewsbury	Patch Pond	360
Stamford	Stamford Pond	100
"	Sucker Pond	125
Strafford	Miller's Pond	100
Stratton	Grout's Pond	100
"	Jones Pond	100
Sudbury	Hinkson Pond	200
"	Lake Hastonia	500
"	Burr Pond	100
"	High Pond	75
Sunderland	Bourn Pond	150
Sutton	Duck Pond	150
"	Big Fish Pond	300
"	Blake Pond	150
Tinmouth	Chipman Pond	400
Vernon	White Lily Pond	100
Walden	Coles Pond	300
"	Lyford's Pond	300
Wallingford	Spectacle Pond	350
"	Fox Pond	100
"	Little's Pond	100
Waterford	Stiles Pond	150
Wells	Lake Austin	3000
Westmore	Willoughby Lake	3800
"	Long Pond	300
"	Bold Hill Pond	300
Westminster	Lily Pond	50
Weston	Reservoir Pond	100
Williston	Hinesburgh Pond	600
Wheelock	Wheelock Pond	100
"	Chandler Pond	75
Whitingham	Sadawga Pond	300
"	Robert's Pond	100
"	Jacksonville Pond	75
Wilmington	Ray's Pond	150
"	Hay Stack Pond	75

Names of Towns.	Names of Ponds.	Area in Acres.
Wolcott	Wolcott Pond	150
Woodford	Big Pond	100
"	Little Pond	75
Woodbury	East Long Pond	300
"	West Long Pond	300
"	Nichol's Pond	100
"	Dog Pond	75
"	Buck Pond	75
"	Sabin's Pond	600
"	Nelson's Pond	75
"	Slayton's Pond	50

We find by the previous reports of the Commission and by correspondence that the following waters have been stocked either by the planting of fry or the introduction of mature fish.

In 1873 there were consigned to Vermont by the United States' Fish Commissioners one hundred and thirty thousand eggs of the Penobscot salmon (Salmo salor), which were hatched at the Cold Spring trout ponds in Charlestown, N. H., and distributed as follows, together with thirty thousand procured at Bucksport, Me.:

May 20, 1874,	15,000	put in	White River	Royalton.
" "	70,000	"	Lamoille River	Georgia.
June 15, "	60,000	"	Dog River	Northfield.
" "	15,000	"	Conn. River	Weathersfield.

There were also placed in the Connecticut river by the aid of the Commissioners of Massachusetts, Connecticut, New Hampshire, and Vermont, nine hundred and twenty thousand of the same.

Of these, however, ninety thousand were put in the tributaries, as follows:

10,000 in Saxton's River	Rockingham.
20,000 in Passumpsic River	Wheelock.
10,000 in Moose River	Concord.
50,000 in Wells River	Newbury.

There was also, through the aid of the United States' Commissioners, a quantity of shad deposited in our waters, as follows:

100,000 in West River.....Brattleboro.
100,000 in Saxton's River.....Bellows Falls.
100,000 in Otter Creek .....Vergennes.
100,000 in Winooski River.....Burlington.

There was, also, the same year deposited by the Vermont Commission, as follows:

1874.		
June 27.	150,000 in Otter Creek.....	Vergennes.
July 15.	215,000 in Connecticut River.....	Bellows Falls.
27.	140,000 "	"
Aug. 1.	120,000 "	"
6.	30,000 "	"
11.	120,000 in Winooski River.....	Winooski.

This made eleven hundred and seventy-five thousand shad deposited in our waters. They have been quite successful in their increase, but do not meet with great praise, as they are not generally considered desirable either to catch with hook and line or for table use, though I find in some sections they are regarded with much favor.

While the salmon have grown up to a maturity of ten or twelve pounds, they do not seem to return or increase, and are seldom taken even near the sea, and the people prefer black bass as a rule, though the worth of the salmon is never called in question.

In 1875 and '76, the following plants were made:

1875.	SALMON.	
May 22.	50,000 in Lewis Creek	Ferrisburgh.
	BLACK BASS.	
28.	50,000 in Battenkill River.....	Manchester.
May 20.	26 in Hall's Pond.....	Newbury.
11.	44 in Long Pond.....	Groton.
11.	47 in Fairlee Lake.....	Fairlee.
Sept. 25.	6 in West River.....	Weston.
1876.		
May 24.	5 in Ponds in.....	Plymouth.
May 30.	20 in Crystal Lake.....	Barton.
June 8.	20 in Memphremagog Lake.....	Newport.

June	8.	17 in Joe's Pond	Danville.
	8.	12 in Berlin Pond	Berlin.
	8.	5 in Martin's Pond	Calais.
	8.	7 in Elmore Pond	Elmore.
	8.	30 in Ray Pond	Wilmington.
	8.	30 in North Pond	Marlboro.
	8.	80 in Monkton Pond	Monkton.
Oct.	20.	16 in Sucker Pond	Stamford.
	20.	20 in Dorset Pond	Dorset.
1879.			
June	6.	50 in Reservoir Pond	Bennington.
	10.	50 in Berlin Pond	Berlin.
1882.			
June	10.	17 in Newark Pond	Newark.
	10.	17 in Benn's Pond	Sutton.

POTOMAC BASS.

Oct.	28.	127 in Otter Creek	Clarendon.
	30.	75 in Passumpsic River	St. Johnsbury.
	30.	75 in Winooski River	Montpelier.
	30.	18 in Black River	Cavendish.

LAND LOCKED SALMON.

April	19.	5,000 in Fairfield Pond	Fairfield.
May	2.	5,000 in Franklin Pond	Franklin.
	3.	5,000 in Lake Dunmore	Salisbury.
	5.	6,000 in Winooski River	Essex.
	11.	1,000 in Kettle Pond	Harris Gore.
	15.	1,500 in Barton Pond	Barton.
	15.	1,000 in Harvey's Pond	Barnet.
	19.	1,500 in Seymour Lake	Morgan.
	19.	10,000 in Orwell Ponds	Orwell.
	19.	2,000 in County Pond	Bennington.
Sept.	1.	2,000 in South Pond	Marlboro.

These have not increased as was anticipated, though they are frequently caught of considerable size. Those caught are supposed to be the same as planted, as small ones are not often seen; it is believed that they are not a success.

WALL EYED PIKE.

May	26.	20 in Black River Pond	Ludlow.
1878.			
May	2.	50 in White River	White Riv'r June.
	3.	50 in Connecticut River	Bellows Falls.
	6.	50 in White River	Hartford.
	7.	50 in Winooski River	Jonesville.
	7.	50 in Dog and Onion Rivers	Montpelier.
1879.			
May	8.	50 in Otter Creek	Pittsford.
	10.	50 in White River	Royalton.
	12.	50 in Long Pond	Groton.
	13.	50 in Berlin Pond	Berlin.
	14.	50 in Colchester Pond	Colchester.
	15.	50 in Shelburne Pond	Shelburne.
	16.	100 in Plymouth Pond	Ludlow.
	28.	50 in St. Catharine Lake	Wells.
Oct.	15.	50 in Lake Bomoseen	Castleton.

These have in several ponds increased wonderfully, and are liked by some. and condemned by others. There is no doubt but what they are a success in ponds well suited to them, and hence are worthy of attention.

		OSWEGO BASS.	
1878.			
Nov.	8.	50 in Chipman Pond	Tinmouth.
	15.	50 in Patch Pond	Mt. Holly.
1879.			
Sept.	13.	50 in Londonderry Pond	Londonderry.
	17.	150 in Little Pond	Plymouth.
	18.	300 in Plymouth and Tyson Ponds	Plymouth.
	19.	150 in Reservoir Pond	Ludlow.
	19.	50 in Black River	Ludlow.
	25.	300 in Island Pond	Brighton.
	17.	50 in Danby Pond	Danby.
1881.			
Sept.	17.	20 in Hall's Pond	Concord.
	17.	25 in Joe's Pond	Cabot.

		ROCK BASS.	
1878.			
Nov.	29.	50 in Cook's Pond	Shrewsbury.
	30.	50 in Lord's Pond	Shrewsbury.

1879.			
Aug.	28.	50 in Patch Pond	Mt. Holly.
	29.	100 in Plymouth Pond	Plymouth.
Sept.	12.	25 in Londonderry Pond	Londondery.
Oct.	17.	50 in Danby Pond	Danby.
	17.	50 in Chipman Pond	Tinmouth.
1881.			
Oct.	17.	20 in Hall's Pond	Concord.
	17.	20 in Miles' Pond	Concord.
	17.	25 in Newark Pond	Newark.
	17.	25 in Joe's Pond	Cabot.
	17.	25 in Crystal Lake	Barton.

WHITE FISH.

1878.			
Nov.	12.	50 in Long Pond	Hubbardton.
	13.	50 in Horton Pond	Sudbury.
	14.	50 in Beebe Pond	Hubbardton.
	21.	50 in Lake Dunmore	Salisbury.
	22.	50 in Lake St. Catharine	Wells.

ROCK PIKE.

1879.			
Jan.	4.	50 in Reservoir Pond	Plymouth.

SMELTS.

1879.			
Mar.	9.	100 in Plymouth Pond	Plymouth.
	9.	50 in Ludlow Pond	Ludlow.
	18.	50 in Berlin Pond	Berlin.
	20.	50 in Peacham Pond	Peacham.
	21.	50 in Colchester Pond	Colchester.
	26.	150 in Fairfield Pond	Fairfield.
	26.	250 in Niggerhead Pond	Fairfield.
April	4.	100 in Shrewsbury Pond	Shrewsbury.
	9.	150 in Groton Pond	Groton.
	10.	150 in Memphremagog Lake	Newport.

YELLOW PERCH.

1879.			
Sept.	25.	150 in Island Pond	Brighton.

The bass in suitable ponds have all been a success, and are much called for by the people, as they are a good table fish, of rapid growth and increase ; they are doubtless as desirable as any fish we have.

We have not only visited many ponds, but have had extensive correspondence with people interested in the proper stocking of ponds and streams, and not only find much interest expressed, but have received many urgent requests for black bass, trout, longe, etc., also urgent requests for protection of fish already in the ponds and streams, and in our opinion such requests should be heeded. That it may be seen what is desired by those interested, we append extracts from various letters received and petitions sent us in relation to the ponds and streams of our State.

ALBANY.—"Great Hosmer and Little Hosmer Ponds and our streams are well stocked with pike and trout; what we need is proper protection by such laws as can be enforced."

AVERILL.—"The ponds have not been stocked, but we want good fish in them. Black bass desired."

BARTON—"Crystal Lake was stocked with black bass three years ago. It is thought that they lack food, and suitable food fish for them is much desired. There is muskallonge caught also, but rock bass and protection is desired."

BARNARD.—Stebbens' Pond or Silver Lake has only cat fish and a few pickerel. Bass are asked for if, after a proper survey of the Pond, it is thought they will thrive. "Trout in our small streams need protection."

BARNET.—"Harvey and Ross Ponds were stocked with land locked salmon. They are occasionally caught of good size, but no young are seen. Bass are desired."

"All are much interested in improvement."

BOLTON—"Hinkson Pond is well stocked with bass. They are a success, yet are fished without regard to law. Protection is desired by a law that can easily be enforced."

BRIGHTON—"Island, Spectacle and Black Ponds have had some fish introduced, but all are anxious for improvement, and desire a survey of their waters, and such fish as are suitable introduced. They are very anxious for protection of their fish by laws easily enforced against worthless men that never have any money to pay fines. Such men wantonly destroy the fish out of season."

CABOT.—"Mollie's Pond: Black bass have been introduced here, with success." Survey of other ponds asked, and such plants as seem desirable; also protection.

CASTLETON.—Bomoseen Lake has had land locked salmon in considerable quantities, but they do not succeed. Oswego bass, whitefish and rock bass succeed well and are plenty. More efficient laws are needed, such as will imprison if fines are not paid; especially laws against netting, spearing and dead lines. Any good laws for protection are desirable, but penalties that cannot be escaped are desired.

CHARLESTON.—"Echo Pond and Pensioners' Pond have never been stocked with success, if at all, and there is an urgent demand for the survey of the waters, and proper stocking of the same. Laws for the protection of fish, easily enforced, with no escape for the culprit, are desired."

"The waters are clear, and in our opinion well calculated for black bass. If so, they are much desired."

CONCORD.—"Miles' and Hall's Ponds have recently been stocked, but no survey made. Such is earnestly requested, that the best possible fish may be introduced, and it is hoped we may have better laws for protection of what we do have."

CRAFTSBURY.—"Three large ponds have not been stocked, but bass are earnestly desired if, in the opinion of the Commission, they will thrive."

DANVILLE.—"Joe's Pond has been stocked with black bass, but as yet few are caught. Protection to fishing out of season is desired."

DORSET.—North Dorset Pond has been stocked with black bass with great success. Protection during spawning season is all that is desired.

EDEN.—"Three ponds—black bass are called for. Muskallonge now in the ponds do not thrive well. Protection against men without money desired."

FAIRFIELD.—"Fairfield and Metcalf Ponds were stocked with landlocked salmon, but few are caught and no young seen. They are not considered a success. Earnest requests to survey and stock ponds."

Fairhaven.—"Inman Pond was stocked with landlocked salmon, perch, pike and black bass. The bass are a perfect success, increasing wonderfully. Protection in close season needed, by laws that any one can enforce and no one escape the penalty."

Hancock.—Hancock Pond is a trout pond, and it is very desirable to increase this supply. Trout spawn or fry are much desired.

Lunenburgh.—Neal's Pond contains a great many perch, and is doubtless an excellent pond for bass. The people much desire to have it stocked, and the law enforced in the close season.

Monkton.—"Has been stocked with bass which have become abundant and permanent. Protection desired."

Morgan.—Seymour Lake was stocked with landlocked salmon, and though a few have been caught they are not thought a success, and black bass are desired if, in the opinion of the commission, they will thrive. Muskallonge are sometimes caught but are not abundant.

Newark.—Newark Pond had a few black bass put in in 1881, but more are desired, as they have not been seen. Better protection laws are also asked for.

Newport.—A request to examine the lake, and stock as thought best.

Ryegate.—Symes and Tickleneeked. The last named we are petitioned to stock with black bass. The other is stocked with pike, which give good satisfaction.

Sheffield.—Long Pond has been stocked with salmon, which have not been a success. Black bass are earnestly called for, if after a survey they are thought to be desirable for the pond.

Strafford.—Miller's Pond; petition to stock with black bass, or such fish as best.

Stratton.—Two ponds, the stocking of which is much desired.

Sudbury.—Black bass asked for, with protection.

Tinmouth.—Chipman Pond was stocked with bass: doing well. Protection against men unable to pay fines asked for.

Vernon.—White Lily Pond. A survey desired, and such fish as will give best returns, with rigid protection.

WALDEN.—"Desire black bass for their ponds, if they are suitable, and protection."

WILMINGTON.—"Ray Pond stocked with black bass with great success. Hay Stack Pond has no fish in it. It is reported that none can live there. If there can, it is a desirable pond, but none are now found, either in the pond or in the stream that runs from it, until you get at least one fourth mile away. The water seems all right, but no fish."

We have selected the foregoing statements from some five hundred different letters received, as showing the general expression of all. They show a great desire on the part of the people to have our waters made more productive. There is also in connection with the desire to stock ponds, a general desire expressed for more trout in our brooks; and it is the opinion of your Commissioners that three or four cheap trout hatcheries would be of great benefit, as through them our brooks could be restocked, and the fishing greatly enhanced, and the result would be a large profit on the outlay.

OUR LAKE CHAMPLAIN FISHERIES.

This is one of the finest lakes for the raising of fish on the continent, and is very well stocked. It should be the great sporting ground for those that delight in such sport, as our Vermont hotels are ample and first class, and the various camping grounds about the lake also numerous at the present time, yet they might be more so. Protection is everywhere called for, and that too of the most stringent kind. In the spring of 1882, during the close season, the Burlington *Clipper* reports that from twenty to fifty barrels of lake fish have been shipped daily from the two stations of Alburgh and Swanton. The fish taken are pike perch, commonly called wall-eyed pike by the fishermen; one of the very best, if not the best, fish for the table the lake affords. The flesh of the fish is firm, white, and well-flavored, and it frequently attains the weight of six pounds. These fish are caught in nets in open violation of the laws of New York, Canada, and Vermont. The New York and the Canada authorities vigorously enforce the law, but in Franklin and Grand Isle counties of this State the law has been grossly violated.

Missisquoi bay is the great spawning bed of the lake, and from that bay, and along the shores of Maquam bay and Alburgh, untold quantities of these valuable fish are dragged from their spawning beds every year by a comparatively few pot-house fishermen. They catch them in their fyke nets, which stretch across every avenue whereby the fish pass to and from their spawning beds; they take them in barrel nets, the arms of which reach out and guide them into these prisons, and they drag the beds themselves with seines. Even late in the winter these outlaws ply their unlawful calling; cutting trenches

and drawing their seines under the ice, and also operating their fyke and barrel nets, often with more destructive results than is possible when the lake is clear of ice. The fish caught in this way are almost invariably female fish, and just ready to spawn, so that as they are drawn in the water will be full of ripe spawn which they have shed. Imagine the destruction which ensues. The law imposes a fine of $10 for every fish thus caught, with confiscation of the nets.

But it is a law not easily enforced, and that the present Legislature will make it much better, we earnestly hope. The *Argus* says:

If the wall-eyed pike should be protected from capture during the spawning season for even five years, the lake would swarm with these fish, so that they could be taken with the hook and line in large numbers at all the fishing grounds along our shores, from Alburgh to the head of the lake. Under the imperfect protection of the last few years these pike have sensibly increased in numbers, and if the fish law could only be sternly enforced during the months of April and May, the lake in ten years would swarm with these fish, that have always been more numerous in our waters than the black bass, the only fish of our lake that compares with it in value for the table. The black bass is a fish of different habit from the wall-eyed pike, and is not so much exposed to capture by netting as the pike; comparatively few bass are taken in the seine, but the pike is the easy prey of the poachers and pot-hunting loafers that lawlessly plunder our waters with their nets in the spawning season, In contrast with our wicked waste of fish, we have only to look at Scotland. A good salmon river there returns from $65,000 to $100,000 annually. These are the figures for the river Tweed. We presume the figures for the Tay would be even higher. Now the protection of our lake fish is practically the protection of the food supply and sport of the whole people, not of any favored class, as in England. The best fishing waters in Lake Champlain are so situated that they are open to all who choose to occupy them, and it is strange that our people who rush to the sea shore for blue fish, or to the Adirondacks, Maine, or Canada for trout, should take no pains to protect the fishing grounds along the shores of Lake Champlain, grounds that in point of beauty, accessibility, and the sport afforded, are quite equal to the places we have named. A three-pound black bass affords as good sport to the angler as trout, and properly cooked is an excellent table fish. Lake Champlain is full of beautiful fishing grounds, that only need to be protected in the spring to furnish plenty of sport for the angler. At the West the people seem more keenly alive to the wickedness and folly of wantonly wasting the wealth of nature than we are in the East. New York, however, does fairly protect its fish and game from depletion, as compared with Vermont, for the reason that not only is there more to protect, but because a few earnest men have succeeded

in rousing a strong public opinion in favor of using the wealth of nature with reasonable prudence and thrift. In Europe public sentiment is strong on the subject of wasting either the material wealth or simple beauty of nature.

From the Montpelier Watchman.

The elaborate legislation which the State has devised for the protection of fish in the lakes and large streams is non-effective because the Legislature seems to have lacked the courage, foresight, or disposition, to make the laws effective by attaching to their violation the only reasonable, sensible penalty—arrest, prosecution and punishment as for theft. By means of seines, fyke nets, and the various contrivances employed by mercenary fishermen for capturing fish by shoals, pike and other varieties have been taken from the mouth of the Missisquoi at the rate of from thirty to forty barrels a day. At this season these fish ascend to their spawning grounds, and are an easy prey to piratical assailants. Fish are deposited in those waters by the Fish Commissioners at the expense of the State. It is permitted to take them at the proper time in a proper way, such an one as will not defeat the design to stock the waters of the State with food-fish; but to take them in this murderous manner, and at their spawning season, is an outrageous offence against nature as well as the laws. For this unnatural procedure the laws demand a fine of $10 for each fish so caught or in the possession of a person, and the delivery of the nets to the town treasurer living nearest the locality where they were taken. As the fishermen are usually impecunious individuals, the penalty can rarely be enforced, and the law is practically of no avail against evil doers. There are varying penalties for specific violations, but they differ from the above in degree rather than in kind. In other parts of the lake, and doubtless in other localities in the State, similar depredations are being committed. Fish are being taken out of the public waters more rapidly than the Commissioners can put them in. The fish laws will require the addition of a penalty sufficiently deterrent in its character to secure their reasonable observance, and the next Legislature should be called upon to make the requisite amendment.

The foregoing selections from leading papers are only the echoes from the people that demand proper protection for their fishing grounds, and it is hoped that these notes of warning will not only arouse the legislature to provide wholesome fish and game laws, but to awaken an increasing interest in that too long neglected source of profit to our State—her fisheries.

FISH COMMISSIONERS.

We append the following list of the different Commissioners on Fisheries for the Provinces, States and Territories of North America, from the *Forest and Stream*, corrected by correspondence to date:

DOMINION OF CANADA.—W. F. Whitcher, Commissioner, Ottawa, Ontario.

PROVINCE OF NEW BRUNSWICK.—W. H. Venning, Inspector of Fisheries, St. John.

PROVINCE OF NOVA SCOTIA.—W. H. Rogers, Inspector, Amherst.

PROVINCE OF PRINCE EDWARD ISLAND.—J. H. Duvar, Inspector, Alberton.

PROVINCE OF BRITISH COLUMBIA.—A. C. Anderson, Victoria.

THE UNITED STATES.—Prof. Spencer F. Baird, Washington, D. C.

ALABAMA.—C. S. G. Doster, Prattville; D. B. Huntley, Courtland.

ARIZONA.—John J. Gosper, Prescott; Richard Rule, Tombstone; Dr. J. H. Taggart, (Business Manager) Yuma.

ARKANSAS.—John E. Reardon, Little Rock; James H. Hornibrook, Little Rock; H. H. Rottaken, Little Rock.

CALIFORNIA—S. R. Throckmorton, San Francisco; J. D. Farwell, Niles, Alameda county; W. W. Traylor, San Francisco.

COLORADO.—Wilson E. Sisty, Idaho Springs,

CONNECTICUT.—Dr. Wm. M. Hudson, Hartford; Robert G. Pike, Middletown; George N. Woodruff, Sherman.

DELAWARE.—Enoch Moore, Jr., Wilmington.

GEORGIA.—J. T. Henderson (Commissioner of Agriculture and *ex officio* Commissioner of Fish and Fisheries), Atlanta; Dr. H. H. Cary (Supt.), La Grange.

ILLINOIS.—N. K. Fairbank, President, Chicago; S. P. Bartlett, Quincy; S. P. McDoel, Aurora.

INDIANA.—Calvin Fletcher, Spencer, Owen County.

Iowa.—B. F. Shaw, Anamosa; A. A. Mosher (Assistant), Spirit Lake.

Kansas.—Hon. D. B. Long, Ellsworth.

Kentucky.—Wm. Griffith, President, Louisville; Hon. John A. Steele, Versailles; Dr. Wm. Van Antwerp, Mount Sterling; A. H. Goble, Catlettsburg; Hon. C. J. Walton, Munfordville; Dr. S. W. Coombs, Bowling Green; John B. Walker, Madisonville; P. H. Darby, Princeton; Hon. J. M. Chambers, Independence, Kenton county; W. C. Price, Danville.

Maine.—E. M. Stilwell, Bangor; Henry O. Stanley, Dixfield.

Maryland.—Thomas Hughlett, Easton; G. W. Delawder, Oakland.

Massachusetts.—E. A. Brackett, Winchester; Asa French, South Braintree; F. W. Putnam, Cambridge.

Michigan.—Eli R. Miller, Richland; A. J. Kellogg, Detroit; Dr. J. C. Parker, Grand Rapids.

Minnesota.—1st District—Daniel Cameron, La Crescent; 2d District—Dr. Wm. M. Sweney, Red Wing; 3d District—Dr. Robert Ormsby Sweney, St. Paul; 4th District—No appointment until January; 5th District—No appointment until January.

Missouri.—Dr. J. G. W. Steedman, Chairman, 2803 Pine street, St. Louis; John Reid, Lexington, Lafayette county; Dr. J. S. Logan, St Joseph.

Nebraska.—W. L. May, Fremont; R. R. Livingston, Plattsmouth; R. E. B. Kennedy, Omaha.

Nevada.—Hon. Hubb G. Parker, Carson City.

New Hampshire.—Edward Spalding, Nashua; Luther Hayes, Milton; Albina H. Powers, Grantham.

New Jersey.—Dr. Benjamin P. Howell, Woodbury; Maj. Edward J. Anderson, Trenton; Theodore Morford, Newton.

New York.—Hon. R. Barnwell Roosevelt, 76 Chambers street, New York; Edward M. Smith, Rochester; Richard U. Sherman, New Hartford, Oneida County; Eugene G. Blackford (Fulton Market, New York city,) 809 Bedford avenue, Brooklyn.

North Carolina.—S. G. Worth, Raleigh.

Ohio.—Col. L. A. Harris, President, Cincinnati; Charles W. Bond, Treasurer, Toledo; Halsey C. Post, Secretary, Sandusky.

Pennsylvania.—Hon. H. J. Reader, Easton; Hon. B. L. Hewit, Hollidaysburgh; James Duffy, Marietta; John Hummel, Selingsgrove; Robert Dalzell, Pittsburgh; G. M. Miller, Wilkesbarre.

Rhode Island.—Alfred A. Reed, Providence; Newton Dexter, Providence; John H. Barden, Rockland.

SOUTH CAROLINA.—A. P. Butler, Commissioner of Agriculture, and *ex-officio* of Fish and Fisheries, Columbia; C. J. Huske, Superintendent, Columbia.

TENNESSEE.—W. W. McDowell, Memphis; H. H. Sneed, Chattanooga; Edward D. Hicks, Nashville.

TEXAS.—R. R. Robertson, Austin.

UTAH.—No appointment since the death of Prof. J. L. Barfoot, in April last.

VERMONT.—Hiram A. Cutting, Lunenburg; Herbert Brainerd, St. Albans.

VIRGINIA.—Col. M. McDonald, Berryville.

WEST VIRGINIA.—Henry B. Miller, President, Wheeling; C. S. White, Secretary, Romney; N. M. Lowry, Hinton.

WISCONSIN.—The Governor, *ex-officio*, Madison; Philo Dunning, President, Madison; C. L. Valentine, Secretary and Treasurer, Janesville; J. V. Jones, Oshkosh; John F. Antisdel, Milwaukee; Mark Douglas, Melrose; Christopher Hutchinson, Beetown.

WYOMING TERRITORY.—Dr. M. C. Barkwell, Chairman and Superintendent, Cheyenne; Otto Gramm, Secretary, Laramie; Hon. N. L. Andrews, Johnson county; Hon. E. W. Bennet, Carbon county; Hon. P. J. Downs, Uinta county; Hon. T. W. Quinn, Sweetwater county.

Respectfully submitted,

HIRAM A. CUTTING, M. D.,
HERBERT BRAINERD, } *Com'rs.*

MONTPELIER, VT., Nov. 15, 1882.

APPENDIX.

LAWS FOR THE PRESERVATION AND PROPAGATION OF FISH, GAME AND BIRDS.

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FISH COMMISSIONERS.

SEC. 3867. The governor may appoint two persons, to be styled fish commissioners, who shall confer with the fish commissioners of the New England states and Canada, direct and superintend, in their discretion, the construction of fishways, and, at the expense of the state, introduce shad and salmon, or other good varieties of fish, into such streams, lakes or ponds as they deem suited to the successful cultivation of such fish. But the expense incurred under this section shall not exceed one thousand dollars annually.

SEC. 3868. Said commissioners shall hold their offices for five years, and the governor may fill vacancies.

SEC. 3869. Natural ponds covering an area of seventy-five acres or more, not private property, shall be considered public waters, into which the fish commissioners may introduce choice varieties of fish.

SEC. 3870. When the fish commissioners place fish in a pond or stream, they may post on the banks a notice that fishing therein, or in specified portions thereof, is prohibited for a period not to exceed three years, and they shall give like notice in a newspaper published in the county; and if a person fishes, or attempts to fish in said waters

within the time so specified, he shall be fined ten dollars, with costs, if the prosecution is commenced within six months after the offence is committed, and the penalty shall go to the state; and the prosecution may be commenced on the complaint of a fish commissioner.

FISH WARDENS.

SEC. 3871 is amended to read as follows:

The selectmen of any town may appoint and remove at pleasure, a person to be fish warden in their town, who may arrest on any of the waters, public or private, of this state, or on the waters of Lake Champlain, or on the shores thereof, any person found violating the provisions of chapter 170, Revised Laws, or any amendment thereof, and prosecute such offender before the proper tribunal. Such fish warden shall have the same right that a sheriff would have, to demand and receive assistance in the discharge of his duty under the provisions of this chapter. Any person refusing to aid such fish warden on demand in the name of the state, by such warden, shall be liable to the penalties provided for in section 4285, chapter 200, Revised Laws, which is as follows:

"A person being required in the name of the state, by a sheriff, deputy sheriff, high bailiff, deputy bailiff, or constable, who neglects or refuses to assist such officer in the execution of his office, in a criminal case, or in the preservation of the peace, or the apprehension and securing of a person for a breach of the peace, or in a case of escape or rescue of persons arrested upon civil process, shall be fined not more than five hundred dollars."

GENERAL LAWS FOR THE PROTECTION OF FISH.

SEC. 3872. A person who takes or catches a trout, land-locked salmon, salmon-trout or longe in any of the waters of the state, or has in his possession any such fish captured in the state, between the first day of September in one year and the first day of May of the next year, shall be fined not more than ten dollars for each fish so taken, caught or possessed.

SEC. 3873. A person who takes or catches a black bass in any of the waters of the state, or has in his possession any such fish captured in the state, between the fifteenth day of May and the first day of July in any year, shall be fined not more than five dollars for each fish so taken, caught or possessed.

SEC. 3874. A person who takes or catches a white fish or lake shad in any of the waters of the state, or has in his possession any such fish, taken in the state, between the first day of November and the fifteenth day of the same month in any year, shall be fined not more than ten dollars for each fish so taken, caught or possessed.

SEC. 3875. A person who takes or catches a wall-eyed pike or pike-perch in any of the waters of the state, or has in his possession any such fish taken in the state, between the twentieth day of April and the twentieth day of May of any year, shall be fined not more than five dollars for each fish so taken, caught or possessed.

SEC. 3876. The penalties provided in the four preceding sections shall go one-half to the person who makes the complaint and one-half to the state.

SEC. 3877. Nothing in sections 3870, 3872, 3873, 3874 and 3875 shall prevent a person from fishing with hook and line at any time in the waters of lake Champlain, or streams emptying into such lake within ten miles from the mouth of said streams.

SEC. 3878. A person who takes or catches a trout, land-locked salmon, salmon, salmon-trout, black bass, or longe, in any of the waters of the state, except by hook and line shall, unless liable to a greater penalty under the provisions of sections 3879, 3882, 3883, be fined twenty dollars.

SEC. 3879. All pound-net, trap-net, gill-net, set-net and fyke fishing in the public waters of this state are hereby prohibited; and any person or persons who shall be found fishing with any such pound-nets, trap-nets, gill-nets, set-nets or fykes, shall be punished by a fine of one hundred dollars; and any person discovering any such net or nets thus set for fishing contrary to the provisions of this section may seize the same; and the nets so seized shall go to the treasury of the town nearest which the seizure is made.

SEC. 3880 is amended to read as follows:

All pound-net, trap-net, gill-net, set-net and fyke fishing, or any other device for entrapping or ensnaring fish in the waters of Lake Champlain or of the rivers emptying into said lake not to exceed ten miles from the mouth of said river are hereby prohibited; and any person or persons who shall fish in said waters with any such pound-nets, trap-nets, gill-nets, set-nets, fykes, or any other device for ensnaring or entrapping fish shall forfeit the sum of one hundred dol-

lars, to be recovered in an action on the case founded on this section, one half to be paid to the treasurer of the state and one half to the informer and prosecutor.

Any person discovering any such net, or nets, or devices for ensnaring fish, set or being used in the waters hereinbefore described, or on the shores thereof contrary to the provisions of chapter 170, Revised Laws, or any amendment thereof, may seize the same, and the nets or devices so seized shall be confiscated for the use of the state, and destroyed by the persons seizing the same. Provided, seine fishing shall be allowed during the month of October and the first fifteen days of November in each year, and provided this section shall not be construed to prohibit the capture of minnows for bait, and provided this section shall not be construed to prohibit fishing in said waters with a hook and line, as hereinafter provided.

Any person who takes or catches any black bass, pike, wall-eyed pike, shad, or pond pickerel from any of the waters, public or private, of this state, or from the waters of Lake Champlain, or has any of said fish in his possession between the first day of January and the first day of May in each year shall forfeit the sum of five dollars for each fish so caught, taken or possessed, to be recovered in an action on the case founded on this section, one half to go to the treasurer of the state and one half to the prosecutor. Provided, this act shall not be construed to prohibit the catching of any kind of fish in the waters of Lake Champlain with a hook and line or with a spear.

Sec. 3881. A person who fishes for white fish or lake shad, or for wall-eyed pike or pike-perch with a seine whose meshes are less than one and one-half inches in extension knot to knot, shall be fined twenty-five dollars, one-half of the penalty to go to the complainant and one-half to the state; and shall forfeit the net so illegally used to the state.

Sec. 3882. A person who catches, kills or destroys fish in waters other than private preserves by the use of gunpowder or other explosive material shall be fined twenty-five dollars for the first offense, double that sum for the second, and treble that sum for each succeeding offense, to which may be added, in either case, imprisonment not exceeding ninety days.

Sec. 3883. A person who throws into waters other than private preserves, India coccle (*Coculus Indicus*), or other drug or poison,

for the purpose of catching, killing or destroying fish, shall be fined not less than ten dollars and not more than twenty dollars, to be paid one-fourth to the person who makes the complaint and three-fourths to the town in which the offense is committed.

SEC. 3884. A person who engages in stocking any of the waters of the state with pickerel shall be punished by a fine of one hundred dollars, or by six months imprisonment, or both.

SEC. 3885. A person found on the public waters of the state or the shores thereof, or on private waters or the shores thereof without the consent of the owner or occupier thereof, in the possession of a net, fish-trap, spear, jack, light or gun, with intent to use the same for the capture or destruction of fish, contrary to law, shall be punished by a fine not exceeding ten dollars, or by imprisonment not exceeding thirty days, or both.

EXCEPTIONS TO THE PRECEDING PROVISIONS.

SEC. 3886. The fish commissioners may take fish at any time for stocking ponds, lakes and rivers, and for maintaining and cultivating fish artificially, and for no other purpose, and may grant permits in writing for other persons to capture fish for artificial propagation and maintenance in private ponds, anything in the preceding sections of this chapter to the contrary notwithstanding.

SEC. 3887. A person engaged in the artificial culture and maintenance of fish may take them in his own waters, how and when he pleases, or take them in other waters for breeding purposes, if he gets the written permit of the fish commissioners to do so, and the consent of the owner or occupier of the land, anything in the preceding sections of this chapter to the contrary notwithstanding; but he shall not sell them for food at seasons when their capture is prohibited by this chapter.

PROTECTION OF FISH IN PRIVATE PRESERVES.

SEC. 3888. A person who catches, kills or destroys a fish in private preserves where fish are being bred artificially, without the consent of the owner thereof, shall be fined five dollars for each fish so caught, killed or destroyed.

SEC. 3889. A person engaged in the culture of fish in private preserves may put up notices at convenient places on the premises,

prohibiting fishing on said premises. After such notice is publicly given, a person who enters upon said premises and catches any fish, or fouls the water thereof with any substance injurious to the life and growth of the fish, or breaks or destroys a dam, reservoir or embankment, or diverts the water, or does any damage to said premises, shall be fined one hundred dollars or imprisoned not more than six months, and shall be also liable to the owner thereof for the damages.

PROTECTION OF GAME AND BIRDS.

SEC. 3890. A person who, prior to the first day of November, 1886, pursues, takes or kills, within the state, a wild deer, or has in his possession a wild deer or part thereof so taken or killed, shall be fined fifty dollars. And the possession of the meat or hide, or any part of a wild deer, shall be presumptive evidence that the person having it in his possession is guilty of a violation of this section.

SEC. 3891. In prosecutions for offenses under the preceding section it shall not be necessary to state in the complaint, nor prove, in what town of the county the offense was committed.

SEC. 3892. It shall be lawful to kill a dog found pursuing wild deer prior to November, 1886, if such dog is killed while in the actual pursuit of deer.

SEC. 3893. A person who kills, catches or destroys a mink, beaver, fisher or otter between the first day of April and the first day of November in any year, shall be fined twenty dollars, to be recovered before a justice, one-half to go to the person who makes the complaint and one-half to the state.

SEC. 3894. A person who kills by poison a wild deer or elk, mink, beaver, fisher or otter shall be fined not less than ten dollars for each animal so destroyed.

SEC. 3895 is amended to read as follows:

No person shall take or kill within the state a quail, woodcock, or ruffed grouse commonly called partridge, between the first day of February and the first day of September in each year, nor a woodcock between the first day of February and the fifteenth day of August in any year, nor a wild goose or wild duck, other than a wood duck, between the first day of May and the first day of September in any year, nor have in his possession a woodcock, quail, partridge, goose or duck

taken or killed in violation of this section; nor shall a person at any time within the state take or destroy the eggs of either of such birds or have in his possession any such eggs taken in violation of this section or take any such bird by means of a snare, net or trap. A person violating any of the provisions of this section shall forfeit ten dollars, one-half to go to the informer and one-half to the state.

BIRDS.

SEC. 3896. A person who intentionally shoots or otherwise wounds, kills or destroys, entraps, ensnares or captures, a robin, blue bird, yellow bird, cherry or cedar bird, cat bird, king bird, sparrow, lark, bobolink, thrush, chickadee, peewee, wren, warbler, woodpecker, martin, swallow, night-hawk, whippoorwill, ground bird, linnet, plover, tatler, phœbe, creeper, bunting, or humming bird, or destroys the nest or eggs of any of said birds, shall forfeit ten dollars, which may be recovered in an action of debt, with costs, by any person who sues for the same.

POSTING LANDS.

SEC. 3897. When the owner of enclosed land conspicuously posts on the same a notice that shooting, trapping or fishing thereon is prohibited, if a person thereafter wilfully enters upon such land without the permission of the owner, for the purpose of shooting, trapping or fishing, the owner may recover against such person, in an action of trespass for such entry, a penalty of ten dollars, in addition to the damages thereby sustained.

SEC. 3898. The notice mentioned in the preceding section shall be given by erecting and maintaining signboards, not less than two feet long by one foot wide, in at least two conspicuous places on the premises, which notices shall have appended thereto the name of the owner or occupant. A person who breaks down, defaces or injures such signboard shall be fined ten dollars.

SEC. 3899. The presence of a person, without permission of the owner, and with the implements of shooting, trapping or fishing, upon land so posted shall be taken as *prima facie* evidence of a wilful entry by him thereon, for the purpose of shooting, trapping or fishing.

[JUSTICES TO HAVE JURISDICTION.]

SEC. 3900. Justices of the county shall have concurrent jurisdiction with the county court of offenses under this chapter.

PRIVATE BILL.

It is hereby enacted by the General Assembly of the State of Vermont:

SEC. 1. It shall not be lawful for a person to catch fish in the waters of Lake Bomoseen in the town of Castleton by the use of any seines, nets, spears, or other device for entrapping or ensnaring fish. A person who violates the provisions of this act shall forfeit ten dollars for each fish so illegally caught, to be recovered in an action on the case founded on this statute, one-half to be paid to the treasury of the town where the complaint is made and one-half to the informer and prosecutor. Provided, this act shall not be construed to prevent a person from fishing in said waters at any time with a hook and line.

SEC. 2. A person found on the waters of Lake Bomoseen or the shores thereof in possession of a net, fish-trap, spear, jack, or any other device for entrapping or ensnaring fish, contrary to the provisions of this act, it shall be taken as *prima facie* evidence of the wilful intent of such person to violate the provisions of section 1 of this act, and such person so found shall be punished by a fine not exceeding ten dollars, or by imprisonment not exceeding thirty days, or both.

SEC. 3. This act shall take effect from its passage.

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Address on "Parasitic Insects of Domestic animals."
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The Frozen well at Brandon.
Report of State Cabinet for 1875.
Address on our "Insect enemies."
Report of State Cabinet, 1876.
Address on Climatology of Vermont in 1877.
How to fortell Storms, etc.
Address on "Microscopic Fungi," Rust, Smut, Mildew and Mould; also, Animalcules, Water Mites, Sugar Mites and Trichina Spiralis.
Report of State Cabinet for 1878.
Notes on Building Stones and Lecture on "Plant Growth," 1880.
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